Compressed Air Magazine

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STOPING A CANADIAN GOLD VEIN

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A Monthly Publication Devoted to the Many Fields of Endeavor in which Compressed Air Serves Useful Purposes

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Moving 500,000 Tons of Rock to Shorten a Road 1,600 Feet

THE HALFWAY MARK
This picture shows the half-completed fill as it looked from a point about midway up the north slope of the ravine. The comparative smallness of the trucks perched on top of it gives a fair idea of the hugeness of this elongated rock pile. At the stage which is illustrated, the fill contained about 250,000 tons of material and extended approximately 500 feet out from the opposite hillside.

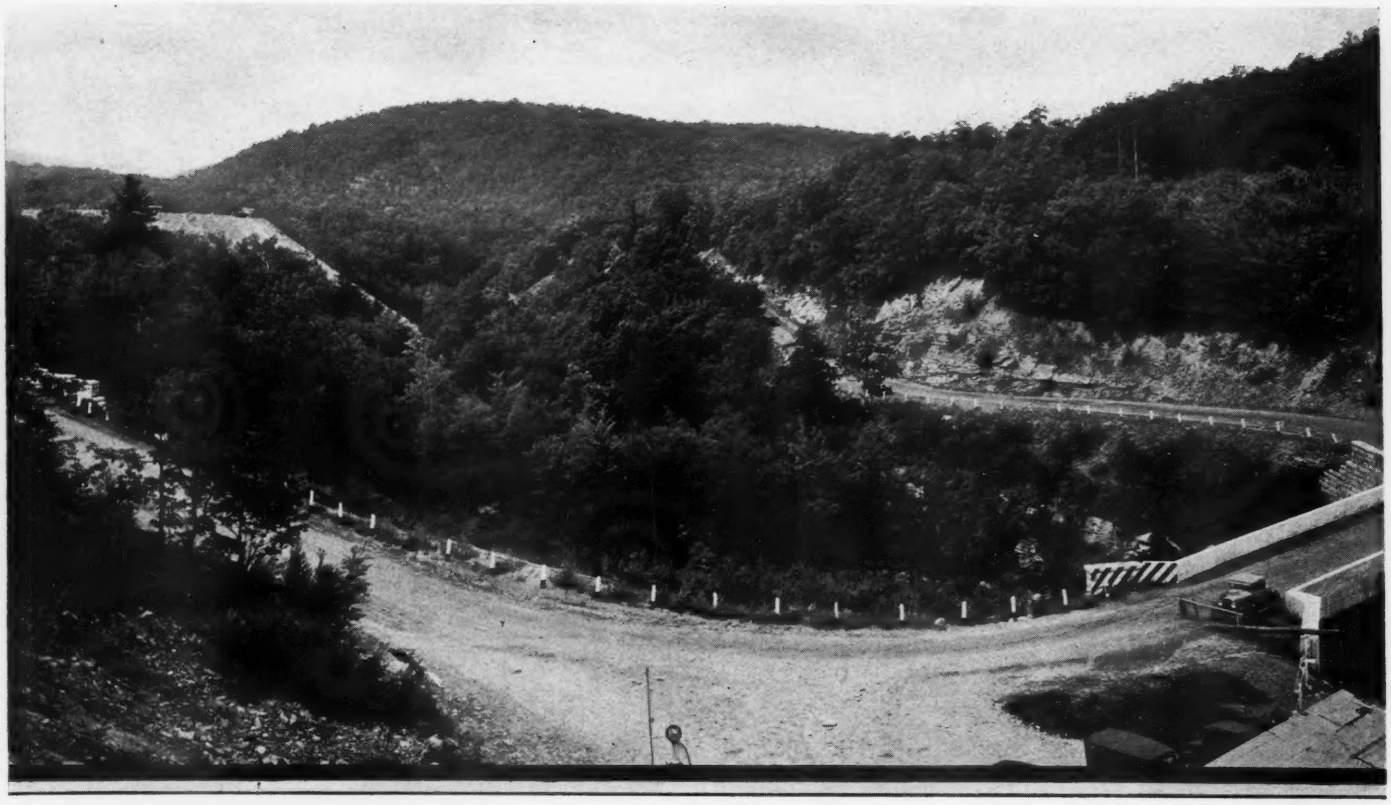
ALLEN S. PARK

IMAGINE, if you will, a block of solid rock 150 feet square at the base and more than 300 feet high being broken up with rock drills and dynamite, transported half a mile or more in trucks, and all dumped into one mammoth ridge across a deep ravine. Save that the rock is being taken from two cuts in a mountainside, the foregoing is a fairly accurate summarization of what the W. Grant Raub Company of Red Lion, Pa., is now doing in the vicinity of Wilkes-Barre, Pa.

The job in point is reputed to be the heaviest piece of highway construction work ever carried out in Pennsylvania, and it is probable that it will rank well on that score with any project of similar sort in the country. It calls for the excavating, transporting, and depositing of 257,058 cubic yards of rock in order to rebuild a section of road less than a mile long. All this material is being placed in one fill. Throughout the summer a fleet of twelve to fourteen trucks has added as many as 400 loads a day to this elongated pile, but it has seemed to creep forward at a snail's pace and will not be completed until well into the winter.

Officially designated as Route 170, Section 8, in the Pennsylvania Department of Highways' program, this is a Federal Aid project located in Luzerne County about two miles south of Wilkes-Barre on U. S. Interstate Highway No. 309, which is known locally as the Wilkes-Barre-Hazelton Turnpike. As persons familiar with the section are aware, Wilkes-Barre lies in the broad valley of the Susquehanna River at the northern base of one of the Appalachian ridges, and all southbound traffic from the city must negotiate a rise of approximately 1,000 feet. The low point in this elevation is a saddle between Wyoming and Openobscot mountains, and it is there, at an elevation of 1,630 feet, that the main lines of the Lehigh Valley Railroad and the Central Railroad of New Jersey make their crossings. This pass, which is called Mountain Top, is likewise the route selected for the highway.

The improvements now being made are on a section of the road somewhat more than a mile below the summit. In order to cross the steeply walled Canyon of Pine Run—a small stream that is the source of water supply for the Town of Ashley and a section of Wilkes-Barre, the ascending highway temporarily reverses its prevailing grade and goes downhill as it cuts back in an upstream direction to reach a point near enough to stream level to permit bridging. There is a sharp turn at the bridge and another one after crossing it, as the road from there on runs in an almost counter direction to its previous course and resumes its ascent of the mountainside. This maneuver gives rise to a dangerous hairpin turn. Also, because of the elevation that is lost in descending into the ravine to make the crossing, the grade is



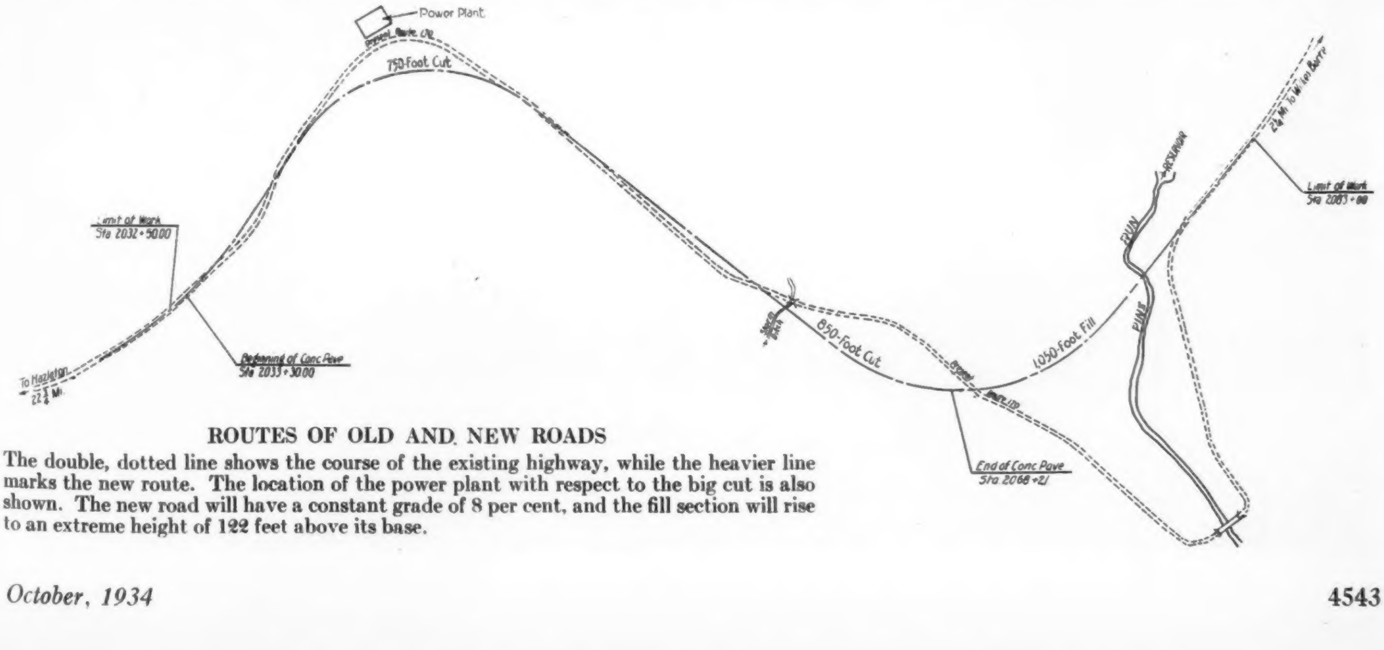
THE FILL TAKES FORM

This view shows the hairpin turn that is being eliminated; and, near the top at the left-hand edge, the fill that will replace it may be seen extending out from the side of the ravine. At the time this picture was taken, in September, almost half of the 318,000 cubic yards which the fill will contain had been deposited. When completed, it will join the extension of the road shown on the right.

necessarily high beyond that point and reaches a maximum of 13 per cent.

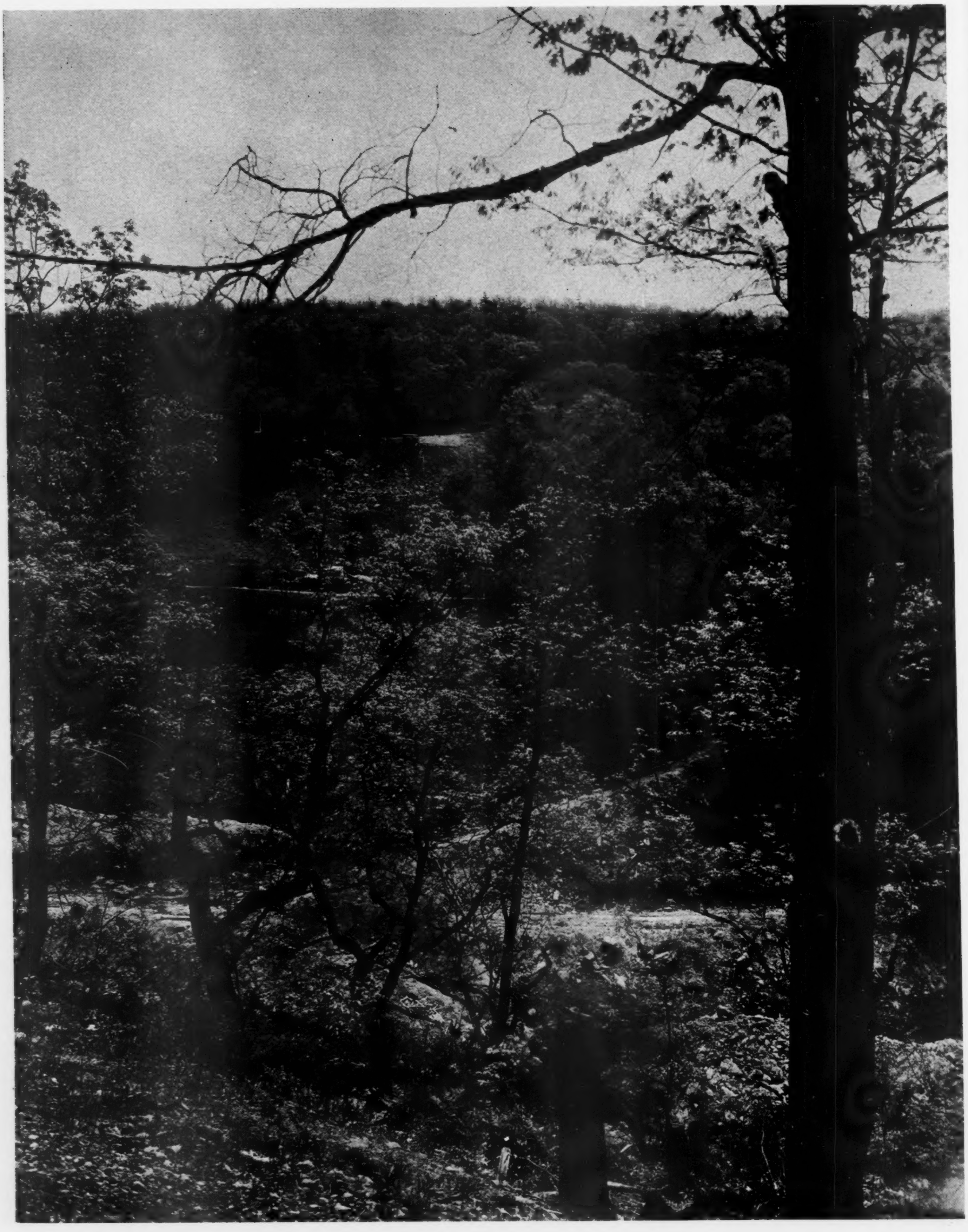
It is for the elimination of this hazardous stretch of highway that more than 250,000 cubic yards of rock is being moved. Approaching Pine Run from the north, the relocated section will cross the ravine on a sweeping curve built upon the fill. In order to avoid sharpening this curve when it reaches the south slope, the road will cut back into the mountainside and gradually swing out again to the approximate line of the existing sidehill stretch. A few hundred feet farther on, where a protruding knob of rock is now rounded by a rather sharp curve, another cut will be made to secure better alignment. All this new highway will be built on a constant 8 per cent grade. The saving in travel distance which will result will be of minor importance, since the rebuilt section will be 5,050 feet long as against only 1,650 feet additional for the present one. However, the removal of the sharp curves and the reduction in the grade will greatly improve driving conditions and permit traffic to move faster with greater safety. The new stretch will have a minimum graded width of 30 feet, 20 feet of which will be paved with concrete. The Raub contract includes both the grading and the surfacing. It is expected, however, that it will require two years for the fill section to settle sufficiently to form a stable base for pavement, and therefore it will be surfaced temporarily with black top.

The dimensions of the fill are quite impressive. It will be 1,050 feet long and have an extreme height of 122 feet. From toe to toe at this deepest point it will measure 309 feet, or more than an ordinary city block. It will taper upward to a top width of 38 feet. From a point in the Valley of Pine



ROUTES OF OLD AND NEW ROADS

The double, dotted line shows the course of the existing highway, while the heavier line marks the new route. The location of the power plant with respect to the big cut is also shown. The new road will have a constant grade of 8 per cent, and the fill section will rise to an extreme height of 122 feet above its base.



WHERE HUGE FILL WILL SPAN RAVINE

This picture, made at the outset of the work last spring, shows where the new road will cross the Valley of Pine Run. High up on the opposite south bank, 1,000 feet away, the nucleus of the fill may be seen taking form in a clearing. When completed it will make a sweeping curve to the left and come back to the north side at a point a little above and to the left of the spot where the cameraman stood. In crossing the ravine to the far side, the road will climb about 80 feet.

Run, either upstream or downstream, it will have the appearance of a great earthwork dam thrown athwart the ravine. Motorists driving across it will gain a view akin to that which would be afforded from the top of a 12-story building. Needless to say, this elevated section of the highway will be amply protected by guard rail.

Although 257,058 cubic yards of rock will be excavated from the mountainside, it will amount to something like 318,000 cubic yards when it is deposited in the fill. This apparent anomaly is owing, of course, to the fact that rock to be excavated is measured in the solid and that when it is reassembled it "swells" by about one-fourth its volume because of the voids between pieces.

Provisions had to be made for passing the stream through the base of the fill, and this has been done by constructing a reinforced-concrete culvert of horseshoe cross section. Fortunately, the deepest part of the ravine is near the north side, and as the fill is being built progressively across from the south side, the necessary operations in the bottom could be carried on while the ridge was being gradually extended toward it from the opposite slope.

The cuts, like the fill, are quite beyond the proportions of ordinary excavations of this kind. Their combined length totals 1,600 feet, of which 850 feet represents the lower and 750 feet the upper cut. However, despite its relative shortness, the upper one will be by far the larger because of its greater depth, and is, accordingly, contributing a proportionately bigger yardage to the fill. Measured on its uphill side, this deeper excavation will be carried to a point 115 feet below the original ground surface. Removal of the rock it contains constitutes virtually a quarrying operation.

When the contractor entered upon the work last April, steps were taken to begin opening up both cuts, but major attention was paid to the larger one and comparatively little was done on the other until the end of the summer, at which time additional equipment was brought in to make this extension of activities possible.

With a vast quantity of heavy drilling ahead, conditions called for sturdy equipment, and wagon drills were selected as most suitable for the work. Two Ingersoll-Rand X-71 units were purchased and placed in operation at the site of the big cut. Until September, when a third machine of the same type was added, these two drills supplied rock for as many as five power shovels. They first leveled off a working area near the highest point of the cut area, the holes being carried to depths as great as 24 feet. Subsequent operations have consisted of benching at various points, holes being drilled to a maximum depth of 15 feet on 7-foot centers. This enables the rock to be removed in 12-foot lifts. The formation varies from a fairly soft shale to slate and hard schist and has a banded structure which dips about 15° from the horizontal.

Compressed air for running these drills, as well as "Jackhamers" for block-holing and miscellaneous drilling, is supplied by Ingersoll-Rand portable compressors. Throughout the summer, two 370-cfm., oil-engine-driven units with 2-stage, air-cooled compressor cylinders sufficed. As drilling is carried on an average of 23 hours a day, these machines have operated on the same schedule. They have shown an average fuel-oil consumption of 4 gallons an hour each, the hourly cost for power being about 30 cents. At the time the additional wagon drill was put in service, a third 370-cfm. portable was provided. It is similar to the initial units except that it is driven by a gasoline engine. These machines are housed in a frame structure situated between the two cuts.

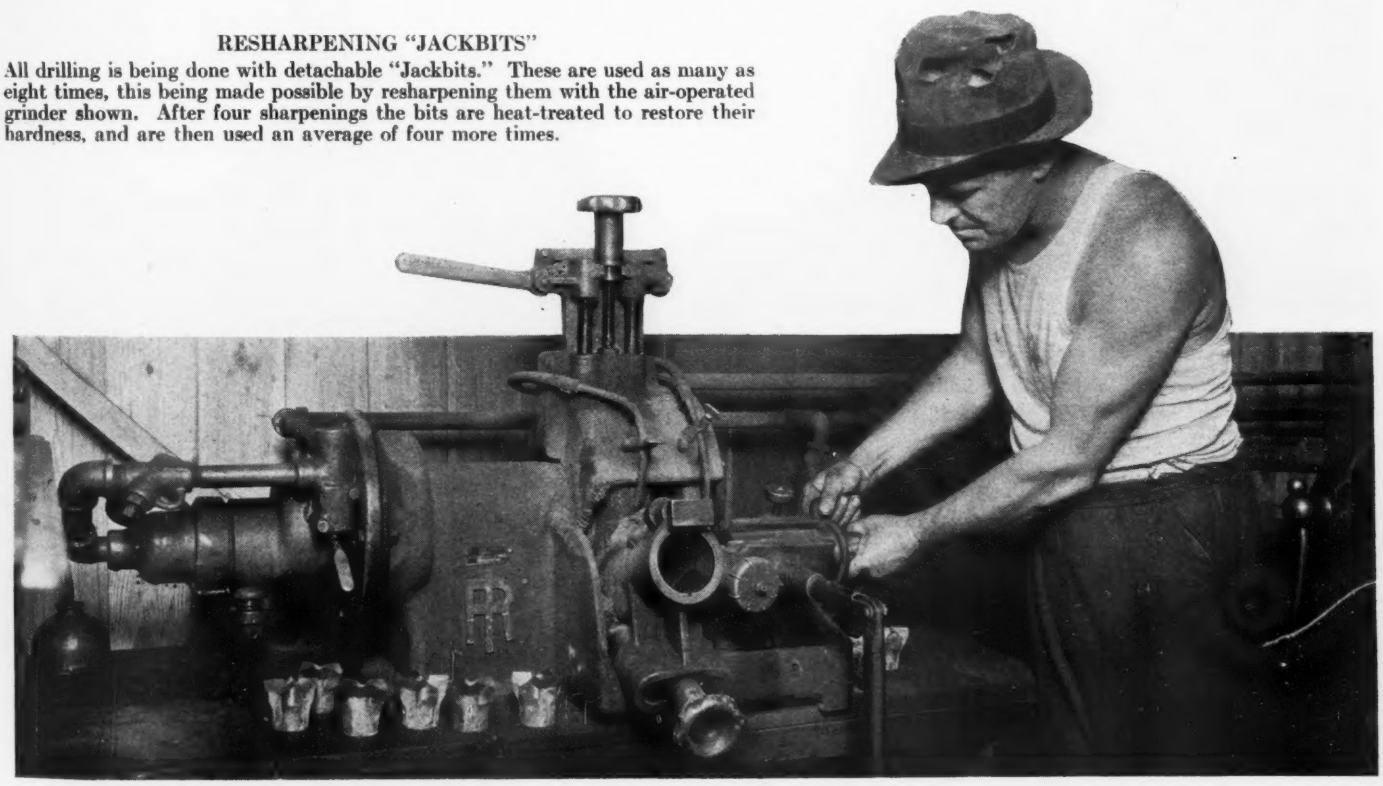
All drilling is being done with "Jackbits," which have averaged from 22 to 26 inches of hole each before requiring resharpening. Original bits have a 3-inch gauge. By means of a JA-4 "Jackbit" grinder they are resharpened four times, the gauge being reduced 1/8 inch with each reconditioning. At this stage, when the gauge is 2½ inches, they are heat-treated, and with their temper thus restored are resharpened four times more and thus progressively reduced to a final gauge of 2 inches. These bits are of the side-hole type.

Loading in the big cut is being done under a subcontract by H. J. Williams Company, Inc., of York, Pa. Three power shovels are in use, a Marion Type 450 of 1¼-cubic-yard capacity, a Marion Type 371 of 1¾-cubic-yard capacity, and a 1-cubic-yard Bucyrus-Erie. Trucks are rented by the Raub Company on an hourly basis. In the lower cut the Raub Company is doing the loading and is employing two shovels.

Because of the narrow top width of the fill it is difficult and dangerous to attempt to turn trucks there and, accordingly, they back out and dump their loads, after which they are in normal position for the return trip. A Caterpillar "Thirty" equipped with a bulldozer is stationed at the end of the fill to keep the surface to grade. This

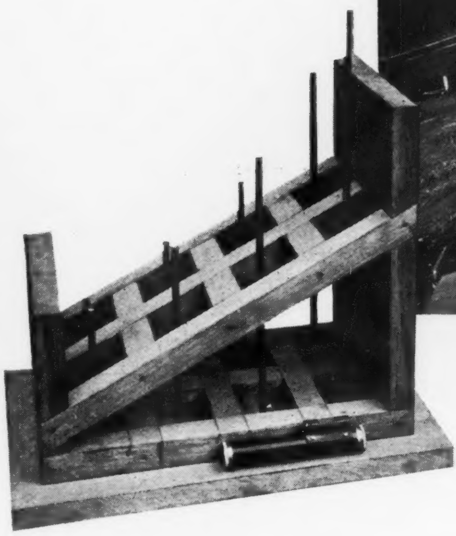
RESHARPENING "JACKBITS"

All drilling is being done with detachable "Jackbits." These are used as many as eight times, this being made possible by resharpening them with the air-operated grinder shown. After four sharpenings the bits are heat-treated to restore their hardness, and are then used an average of four more times.



CONSTRUCTING CONCRETE CULVERT

Pine Run will pass through the base of the fill in a reinforced-concrete conduit nearly 400 feet long. Because of the inaccessibility of the bottom of the ravine, an aerial tramway was used to transport materials for the culvert. Ready-mixed concrete was trucked five miles from Wilkes-Barre, about 1,000 trips being required. From bottom to top, these pictures show a tramway bucket being filled, conveyed down the steep hillside, and chuted into the forms.



WHERE CAUTIOUS BLASTING IS DEMANDED

The picture above shows the nearness to the big cut of a 90-year-old power house and emphasizes the care that must be taken to prevent damaging it when blasting. As a means of positively checking the vibration of the building induced by the shots, the contractor uses the vibration pins illustrated at the left. These narrow steel rods, balanced on their ends, are extremely sensitive to shock, and the longer ones topple over at the least jar. The cut will be excavated to a point 30 feet lower than the surface of the existing road seen at its far edge.

fill differs from the usual highway fills in that it is governed by railroad specifications. In effect, this means that the contractor is not obliged to compact the material by depositing it in layers and rolling it or otherwise treating it. This permits making it on grade all the way and extending it by dumping all material at the forward end.

As has been previously mentioned, while the fill was being started preparations were in progress at the bottom of the ravine for the installation of the culvert. These consisted of going through on the line of the structure with an Erie steam shovel of 1-cubic-yard capacity and of excavating to a solid foundation below the gravel of the stream bed. The excavated material was side-cast. Because of the precipitous slope of the ravine it was impossible to reach the shovel by truck, and its coal supply was hauled partway and carried the remaining distance in sacks. The culvert has an overall height of 15 feet and is 384 feet long. Its base is 6 feet thick, and the sides and top of the arch are 16 inches thick. It contains 3,000 cubic yards of concrete and 500,000 pounds of reinforcing steel.

The pouring of this structure presented somewhat of a problem in view of the steepness of the ravine. The situation was met by transporting the concrete to the forms from the roadway above and on the north side by means of an aerial tramway. This was a small unit such as is commonly used in the slate quarries of Pennsylvania. It was operated by a Mead-Morrison 3-drum, gasoline-engine-driven hoist stationed on the hillside above the loading point. From a deadman in the hillside back of the hoist, the track cable passed over an A-frame and thence to the bottom of the ravine, where it was moored to the boom of the steam shovel, which served as a movable tail tower. Concrete was hauled five miles from the Wilkes-Barre plant of the Wyoming Valley Ready Mixed Concrete Company—seven 3-cubic-yard transit mix trucks being employed in this service. The cableway was equipped with a 1-cubic-yard bucket: but, as it was not filled to capacity, it required seven trips of the bucket to transport the contents of two trucks. As the hoist operator could not see the bottom of the ravine, all cableway movements were controlled by signals. The concrete was chuted into the forms, as many as seven chutes arranged in conical shape being used to distribute the material evenly to various pouring areas.

The entire structure was built up in alternate sections 32 feet long. Despite the difficulties which attended the operations, good progress was made in constructing this arch, and in one day, when work was continued for sixteen hours, 172 cubic yards of concrete was placed. During the building of the culvert the stream was diverted through a 40-inch corrugated-iron pipe. To protect the concrete arch from damage by falling rocks dumped over the end of the fill, it was covered after completion with 2 feet of hand-placed rock and then blanketed with several feet of earth.

Blasting in the big cut must be carefully controlled to protect a power plant which, as may be noted from an accompanying sketch, occupies a site close by. This structure is the property of the Central Railroad of New Jersey and supplies power for the operation of the Ashley Plane, the highest in a series of three inclined railway tracks over which freight trains are drawn by cables to Mountain Top. By means of these planes an ascent of 1,014 feet is made in a direct line only 2½ miles long, whereas the railroad regularly follows a much longer, circuitous route in order to obtain a grade that is negotiable by locomotives. These planes have been in service since 1843, and the power-plant structure referred to is said to date from the same year. This building is not only near the road work but considerably below it, with the surface sloping steeply toward it. Accordingly, any rocks thrown over the slope in its direction would be fairly certain to hurtle down upon it. Surmounting the power house are two square brick chimneys, each 85 feet high, 13 feet across at the bottom, and 8 feet across at the top, as well as two metal stacks each 63 feet high and 5½ feet in diameter at the top.

As can be readily realized, the nearness of this structure, its advanced age, and the physical conditions which augment the chances of damaging it, constitute a decidedly ticklish situation. Because of these complications, the blasting operations were placed under the supervision of an experienced man and all possible precautions were taken to prevent rocks from flying and to reduce vibration to a harmless point.

The blasting is in charge of Thomas Dove, anthracite manager of General Explosives Corporation, of Latrobe, Pa., and sales representative of that concern at Pottsville, Pa. Under his direction an efficient blasting crew has been trained from the regular force on the job, and

methods of procedure have been developed which are producing satisfactory results.

In order definitely to check the effect of the concussions upon the building, recourse is being taken to an ingenious device known as vibration pins. As illustrated, it consists of a set of eight round, steel pins approximately $\frac{1}{4}$ inch in diameter and of lengths varying from 4 to 15 inches, all standing on end on a wood base. Obviously, it requires only a slight shock to topple over these unstable rods, the longer ones being particularly sensitive to vibration and the shorter ones proportionately less so. It is said that this instrument was developed in Massachusetts a few years ago and is the outgrowth of a lawsuit in which the owner of a house alleged that the latter had been damaged by blasting in the neighborhood. In order to prove the point at issue, the heaviest blasts were duplicated with the vibration pins set up at the house, and the jury was allowed to witness the tests.

Since that time, the device has been used considerably as an indicator of the effects of detonations. Where necessary or desirable, it is possible, through mathematical calculations, to measure vibratory forces quite closely from their influence on the pins. In the case of the construction job under discussion, the pins are set up at various points around the power house from time to time. Thus far there has been but one instance when any of the pins have been bowled over, and in that case only the longest became unbalanced when a large bowlder was broken by mud-capping.

Special attention is given to the loading of holes along the edge of the cut nearest the power house, the purpose being to cushion the shots. Elsewhere, holes are normally loaded by inserting six $1\frac{1}{2}$x8-inch cartridges of 60 per cent ammonia gelatine dynamite followed, after tamping, by 4 or more pounds of 50 per cent ammonia dynamite, which is poured in from cartridges measuring 4x16 inches and weighing $8\frac{1}{3}$ pounds. This is then tamped, the primer placed, and sand stemming poured on top of it. In the case of the holes adjacent to the power house the same procedure is followed except that no 60 per cent gelatine dynamite is used and holes are not tamped. The difference in the effects of the blasts with these two types of loading is explained by Mr. Dove to be akin to the difference between the shooting of a rifle and a shotgun.

The strata encountered are familiarly termed the edge of coal measures and are known from past experience to be productive of blasting difficulties because of their pronounced tendency to fracture. For instance, trouble is met with if holes are left standing long after drilling. Therefore it is the practice to load them without delay.

To guard against misfires, several precautions are taken. Before the stemming is placed, primers are given a galvanometer test to make sure that they are in perfect condition. Also, it is the rule that the blaster in charge shall prepare in advance a rough chart of all holes in a group to be shot and to indicate upon it the method to be used in connecting the wires. This diagram is submitted to the drill foreman for approval before the connections are actually made. When the holes are ready for firing, connection is made with a 100-hole electric blasting machine by means of 250 feet of No. 14 duplex lead wire, but the blaster is required to keep the blasting machine in his possession until permission to fire is given by the drill foreman.

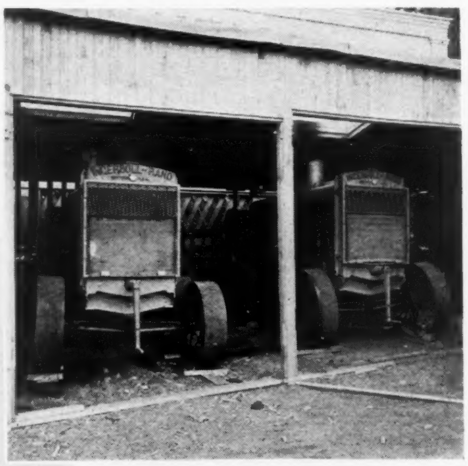
During the month of July considerable trouble was encountered with misfires. Where a group of holes averaging 75 in number was shot, as many as 25 of them —usually in one group or nest—would fail to detonate. As they were generally in the area farthest away from the blasting machine, it indicated that the current being generated was not sufficient to reach them. Such conditions can usually be attributed to excess moisture in the ground or to mineral constituents. As there were almost daily thundershowers at the time, it was impossible to determine immediately which of these possible causes was responsible, but investigation led to the conclusion that the presence of streaks of iron in the rock was primarily to blame. On August 12, a change was made to enameled-wire electric blasting caps, and, although there was a downpour of rain on that day, three blasts of 50, 59, and 78 holes were fired with complete success. The use of enameled wire was continued, and no further difficulty has been experienced.

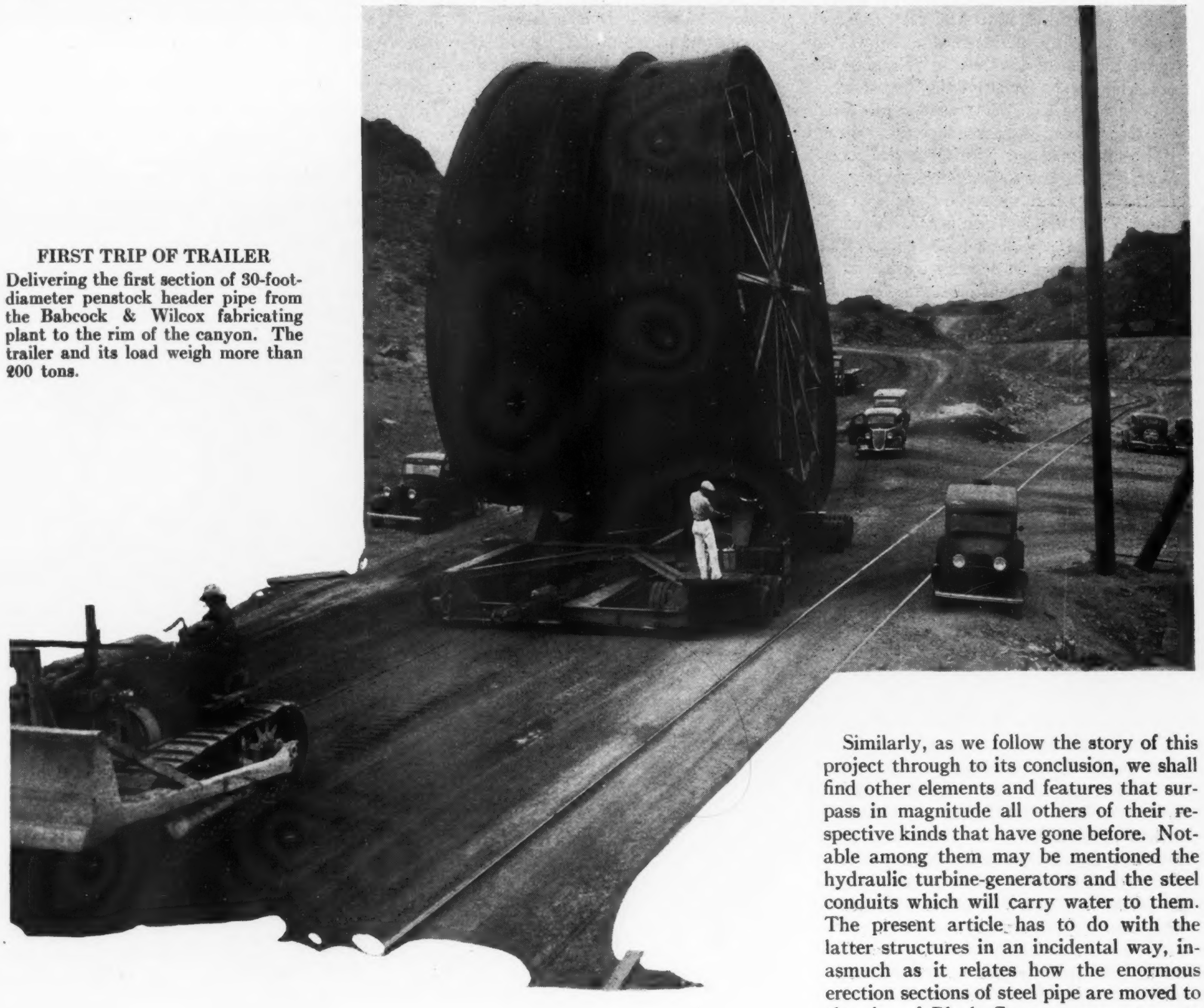
Labor on this contract is drawn from Luzerne County, and working hours are restricted to 30 a week. With several crews, drilling operations and, occasionally, other activities can be conducted on practically a 24-hour basis. At times as many as 150 men have been employed.

Paul S. Raub is serving as superintendent, with Dale E. Dietz as assistant. John L. Borjes is resident engineer for the Pennsylvania State Highway Department.

A HUGE CUT IN THE MAKING

More than a quarter-million cubic yards of rock is being excavated from two cuts in the mountainside. Shown below is the largest one as it appeared when it had been carried about halfway down to grade. The cliff at the left is about 55 feet high, and will be 115 feet high when the cut is completed. In the foreground is one of the three wagon drills that are taking care of the drilling program in these cuts. They work 23 hours daily. The two 2-stage, air-cooled portable compressors pictured at the right are each driven by engines that are operated with low-cost fuel oil. They are in service 23 hours a day. Recently, when the number of drills was increased, a third 2-stage compressor was added.





FIRST TRIP OF TRAILER

Delivering the first section of 30-foot-diameter penstock header pipe from the Babcock & Wilcox fabricating plant to the rim of the canyon. The trailer and its load weigh more than 200 tons.

Huge Trailer Hauls Penstock Pipe at Boulder Dam*

COPELAND LAKE

BECAUSE Boulder Dam is the largest structure of its kind ever built, it logically follows that its construction calls for doing various essential operations on an unprecedented scale and with equipment of unusual size. Descriptions of the work accordingly involve the frequent use of superlatives. In previous articles of this series attention has been directed to the 56-foot diversion tunnels and to the huge 30-drill "jumbos" that played such an important part in their excavation. We have likewise told about the record-size cableway system, the facilities for preparing concrete aggregates faster and in greater quantities than was ever done before on a construction contract, and have described the equipment and methods by which concrete is being mixed and placed in the forms at a rate never before attained.

Similarly, as we follow the story of this project through to its conclusion, we shall find other elements and features that surpass in magnitude all others of their respective kinds that have gone before. Notable among them may be mentioned the hydraulic turbine-generators and the steel conduits which will carry water to them. The present article has to do with the latter structures in an incidental way, inasmuch as it relates how the enormous erection sections of steel pipe are moved to the rim of Black Canyon preparatory to being lowered into position in the rock tunnels that penetrate the cliffs. Here, again, we meet equipment that outstrips anything of the nature previously built.

The fabrication of the steel pipe for the penstock headers and penstocks and its installation within the tunnels constitute an undertaking of such size that the Bureau of Reclamation elected to make it a separate operation and to call for bids covering the work. The contract, which is for approximately $11,000,000, was awarded The Babcock & Wilcox Company of Barberton, Ohio, and that well-known and experienced manufacturer of steam boilers and other types of pressure vessels has been engaged in carrying it out for the past two years. Its task consists of forming steel conduits aggregating 14,500 feet in length and of assembling them within the rocky walls of the canyon. Depending upon the service for which they are intended, these conduits will be of four sizes, their respective diameters being $8\frac{1}{2}$, 13, 25, and 30 feet. They will have wall thicknesses ranging from $\frac{5}{8}$ inch to $\frac{7}{8}$ inch for the smallest size to from $1\frac{11}{16}$ inches to $2\frac{3}{4}$

*Nineteenth of a series of articles on the Colorado River and the building of the Boulder (formerly Hoover) Dam.

inches for the 30-foot size. All these are being made up of flat plates and will require the use of 45,000 tons of material.

Owing to the fact that the larger sizes of pipe are too big, even when built up in small sections, to transport by railroad, it became necessary for The Babcock & Wilcox Company to erect and equip a large fabricating plant near the dam site. The closest suitable location available was at Bechtel, Nev., about a mile from the canyon rim. There, in desert surroundings, is being done work of a sort that is usually associated only with industrial areas.

One of the accessory but vitally important features that had to be considered in connection with this work was the devising of adequate methods and facilities for moving the huge pipe sections from the fabricating plant to the edge of the canyon for delivery to the 150-ton cableway which stood ready to lower them to any one of four shelves leading to various parts of the tunnel system within the cliffs. Inasmuch as Six Companies Inc. was experienced in problems of this sort and had an organization on the ground, arrangements were made whereby it would take over this transportation task.

The true proportions of the difficulties involved can be comprehended by considering the form and characteristics of an erection section of a 30-foot conduit. A unit of this type consists of two rings, each 30 feet in diameter and 12 feet long, joined end to end and reinforced at their joint with a stiffening member. Each of these two component rings is made of three plates each 12 feet wide, approximately 31½ feet long, and, in the case of the heaviest pipe, 2¾ inches thick. Such plates weigh 23 tons apiece, and when six of them are knitted together the resulting erection section weighs about 170 tons.

There were only two ways by which these sections could possibly be moved—by railroad and by highway. In the case of the former, it was determined that four or six rails would be required to secure lateral stability, involving the laying of additional trackage and the widening of several deep rock cuts on the single-track railroad. Inasmuch as the existing roadway could be used with no changes other than a reduction in the super elevation on some of the curves, the decision was made in favor of the highway, and steps were taken to secure a vehicle of suitable size, strength, and maneuverability to carry the large and heavy loads. The conditions pointed to a trailer as being the most acceptable form of carrier, and no time was lost in having one made to meet the needs.

The trailer was furnished by the C. R. Jahn Company, of Chicago, Ill., and was planned and built by the La Crosse Boiler Company of La Crosse, Wis. It has a framework of steel and is 37 feet 8 inches long by 22 feet wide. It has four wheels at each corner, and is equipped with a hydraulic steering mechanism and with air-operated brakes. Without load, the trailer weighs 41 tons. It was designed to carry a maximum load of 200 tons.

The road from the fabricating plant to the cableway is 1½ miles long and is downhill all the way towards the canyon with a maximum grade of 6½ per cent. Its overall width is 30 feet, of which about 28 feet is surfaced with oil-treated gravel. It has numerous curves, one of which has a radius of 100 feet on the center line, and a grade of 4 per cent. Because of a lack of space in which to turn so large a trailer around, and also because it was recognized

BEGINNING 600-FOOT DESCENT
The first section of 30-foot pipe about to go over the wall for lowering into the canyon by the Government 150-ton cableway. The weight is suspended from special "moonbeam" lifting devices designed to equalize the load upon the track carriage. The holes which are visible in the pipe wall will be used for filling the space around the conduit after it has been set in place with concrete.

that turning it would be attended by certain difficulties and dangers, the unit was made reversible and was equipped with drawbars for hauling from either end. Tractors are employed for the towing.

As the length of an erection section of 30-foot-diameter pipe is 24 feet, and the center of gravity is quite high, wide spacing of the wheels was called for and this, in turn, produced problems in connection with steering the trailer around curves. It was obvious that conventional methods of steering were inadequate under such conditions, because in turning a curve with a 100-foot radius the wheels on the outer arc were certain to be dragged to some extent in keeping up with those on the inner or short arc. This, of course, could not be allowed to happen under such a heavy load because of the disastrous effect it would have on the tires.

As can be noted in one of the accompanying pictures, the four wheels at each corner are supported on two axles. These axles are of the tilting, oscillating type which balances the load and compensates for ordinary road irregularities without materially changing the load-carrying level. The wheels are mounted on Timken double, tapered roller bearings which are lubricated by a high-pressure grease system. On each wheel are two 28x14-inch solid Goodyear tires. These provide a total of 448 inches of tire space on the sixteen wheels. The carrying capacity of each tire is 10,200 pounds, with an overload allowance of 25 per cent in view of the slow speed at which the trailer travels.

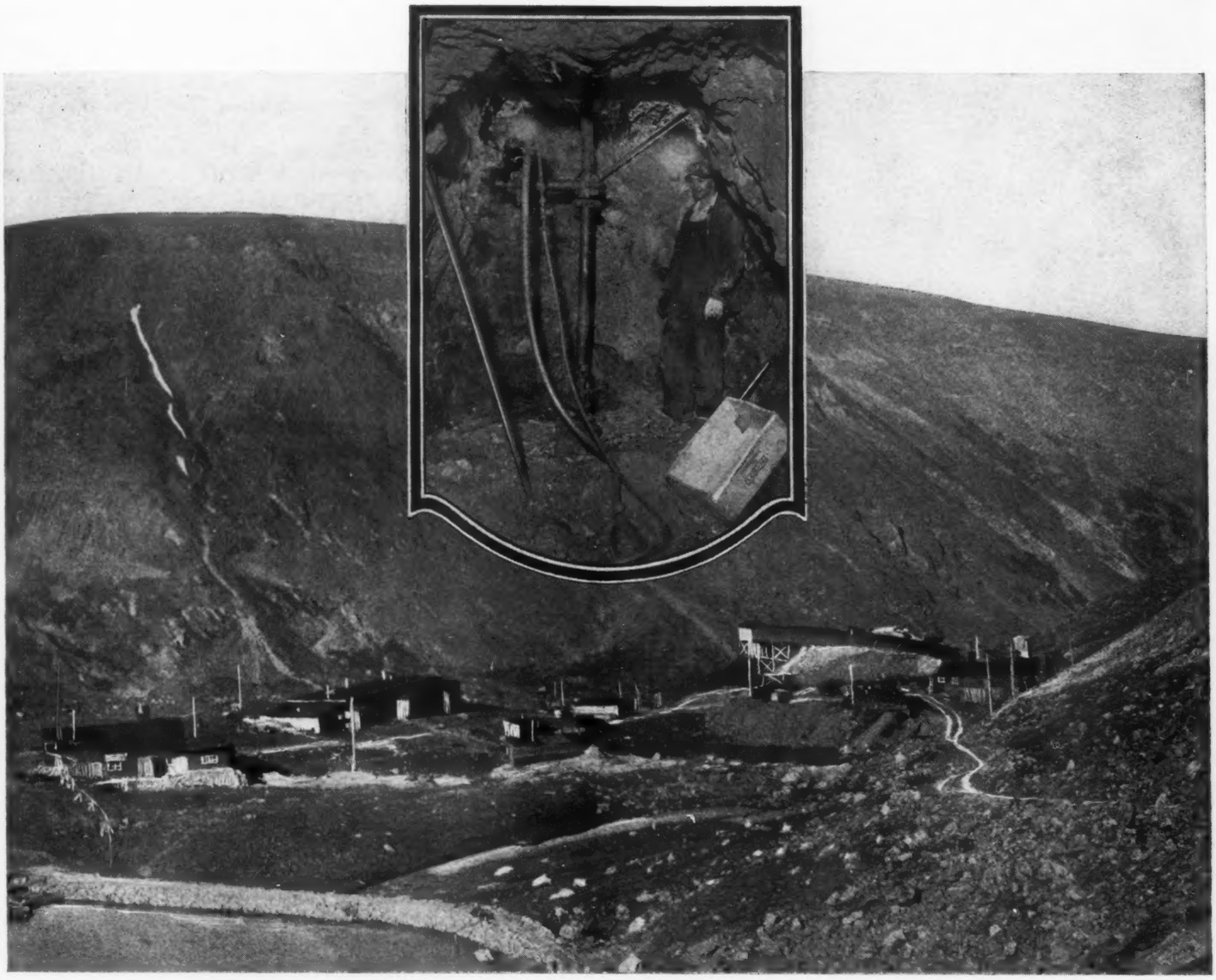
To facilitate turning, each set of dual axles is independently controlled by the steering apparatus. A Northern nitro-alloy steel pump, driven by a 15-hp. gasoline engine and having a capacity of 50 gpm. of oil against 300 pounds pressure, supplies constant equalized pressure to a control cylinder at each set of axles. By means of a compensating link between the two main steering levers, it is possible when on curves to adjust the radius of travel of the inner wheels so as to give all sixteen wheels a rolling action. Steering is controlled through a wheel mounted at one end of the trailer.

As the road is down grade practically all the way from the fabricating plant to the canyon rim, the use of brakes is well-nigh continuous when the heavily loaded trailer is moving in that direction. This naturally makes it imperative that the compressor and other elements in the braking system be of unfailing reliability and efficiency. Bendix-Westinghouse internal-expanding-type brake chambers are mounted on each wheel. They are supplied with compressed air by an Ingersoll-Rand Type 30, air-cooled compressor which is driven by a 5-hp. gasoline engine. This unit has a maximum discharge pressure of 200 pounds per square inch and maintains a constant pressure of from 90 to 100 pounds. In addition to the main air receiver located near the compressor, auxiliary storage tanks are placed at each corner of the trailer. The total braking surface is 3,166 square inches. Emergency features permit stopping the trailer instantly should the towing unit become disconnected or a break occur in any of the air lines to the wheels.

Rubber-covered cradles provide resting places for the pipe—various sizes of these supports being available to accommodate the several different-sized sections.

The Gold Hoard of London Mountain

C. H. VIVIAN



NORTH LONDON MINE

This view, looking east from a point above the property, shows the North London surface structures, with Loveland Mountain in the distance across the valley of North Mosquito Creek. London Mountain is at the right, and the tunnel enters its talus slope at the nearest of the right-hand group of buildings. The road which runs toward the lower right-hand corner of the picture is the old Alma-Leadville stagecoach route. Via this road Leadville is only six miles away, but by the circuitous automobile highway it is 66 miles. An N-75 drifter drill mounted on a column bar in a drift of the mine is in the inset. With it is Charles Fletcher, mine foreman, whose intimate knowledge of London Mountain has enabled him to work out some of the mysteries of its fault system at times with uncanny accuracy.

THROUGHOUT the West, the search for gold continues with unremitting vigor. Not since the first wave of fortune seekers stormed into California over trails blazed by the Argonauts of 1849 has there been a treasure hunt of equal proportions. "Poor man's mining"—placering—has flourished for several years. Spurred on by the depression, thousands of inexperienced but eager workers have been sifting and resifting gulch gravels in every known auriferous region. Few of them have made more than meager wages, but they have maintained their independence, preserved their health and morale, and kept their names off relief rolls.

This churning of surficial materials is still going on with undiminished energy, but, in addition to it, the gold hunt has entered a second phase. With the price of the yellow metal at $35 an ounce by Government manifesto, and possibilities that it will be boosted still higher, capital has poured into the hills and lode mining has been renewed in earnest. As has been the case in placering operations, most of the current activity is centered about previously worked areas, and in these, in turn, major attention is being given mines which were originally opened years ago. There are several reasons for this. With gold at a premium, and with improved metallurgical methods available, it is now profitable to mine ores that were purposely and necessarily left behind by former operators, and a diligent search for deposits of this type is today being made in many venerable camps. Then, also, there is always the chance of discovering new ore bodies in these old workings. Thus, while there is much prospecting of virgin fields, it is safe to say that 90 per cent of the actual mining operations is being carried on in ground that has yielded metal at some time in the past. On every hand the demand is for quickly obtainable gold, and the surest place to get it is in mines that have established records of production. Moreover,

THE TOWN OF ALMA

During its 61 years of existence, the fortunes of this camp have fluctuated widely according to the demand for gold and silver. At present it is experiencing a mild boom, and houses are at a premium. Alma is the terminus of the railroad from Denver and a supply point for the mines of the area. Its elevation is more than 10,000 feet above sea level.

such properties usually have workings already developed, and oftentimes there is equipment on the premises that can be rehabilitated with a minimum expenditure of time and money.

To attempt to single out any one region where old mines are being revivified would be futile. They are scattered from the Rockies to the Pacific Ocean. Dead or dying camps have come to life on every hand. A few months ago most of them were practically deserted: now they seethe with action. Dwellings and mine structures have been refurbished, mechanical equipment put in working order, and underground workings cleaned up, retimbered, and unwatered. There are fires again beneath boilers or, as is more often the case in modern mining, electric power is flowing through transmission lines to isolated locations.

Alma, Colo., will serve as an example of the rebirth of gold mining. It is not one of the larger districts, and in Colorado's past mining history it has been submerged by the greater glories of Cripple Creek, Central City, Leadville, and the San Juan. Yet, during the past three years, one mine there has been the best gold producer in the state. This property, the American, has contributed several million dollars in new wealth to the nation from within the limits of a claim that extends only 600 feet along the vein system.

Thus far, practically all the mines that have been put into production are primarily gold properties. But with silver nationalized, with the price of newly mined metal fixed at 64 cents an ounce, and with rumors of a possible further enhancement in its value, there is much talk of reopening some of the numerous former silver producers which abound in the region. If and when that transpires, Alma will experience a real boom. Right now it is merely at the prosperous stage. Every able-bodied man in the section who wants work has it, and many outsiders have found employment there. The fact is that there is too much work, as the mine owners are reluctant to close down when they are making profits. The larger properties run seven days a week and observe only the major holidays. The real index to the economic health of a mining camp is to be found in the scale of prevailing rentals. Judged by this standard, Alma seems definitely on the mend. In August of this year, $28 a month was the asking price for a 2-room log house with no modern improvements except electricity. Two or three years ago owners would have gladly accepted half that figure had tenants been available.

Although few of the persons not identified with the intriguing business of mining have probably ever heard of Alma, it has an enviable record as a mineral center and dates its existence back to the first years of the rush of humanity which followed the finding of flakes of gold in the gravels of Cherry Creek not far from where the capitol building in Denver now stands. This was in 1859, when knowledge of the geography of the West was vague and the entire vast domain that is now Colorado was called the Pike's Peak region. It required only a few weeks after the Cherry Creek discoveries for prospectors to filter back into the mountains along the watercourses, and those that followed Clear Creek almost due westward were the first to reap substantial rewards. Almost simultaneously, William Green Russell and John Hamilton Gregory made important finds in Gregory Gulch and at Jackson's Bar, which two communities later came to be known, respectively, as Black Hawk and Idaho Springs.

Soon the section was crowded with gold seekers, and the overflow forged on up and over the flanks of the range. Some continued on to Leadville, and others followed the crest of the divide southward and descended the headwaters of Tarryall Creek, a tributary of the South Platte River, which was given this name because of the decision of the tired group to stop there until they were rested. This pioneer band of prospectors was composed of men originally from Wisconsin. They did their first actual placering a few miles from the present Town of Como and found gold immediately.

Just how news of their success traveled across the high mountains to the nearest habitations is not known, but soon there was a great influx of fortune seekers. They were not given a hearty reception; and, finding all the ground staked out by the early comers, they were obliged to move on. As they left, however, they resolved that, should they find any gold-bearing gravels, they would share their good luck with later arrivals.

Proceeding across country a few miles to the South Platte River, they discovered rich deposits. True to their announced creed, they named their settlement Fairplay; and it is recorded that they shared their holdings with prospectors who followed them. In any event, Fairplay became the largest town in the region and remains so today. It is the county seat of Park County, one of the original subdivisions of the Territory of Colorado, and located in almost the exact center of the present state. The county derives its name from the fact that a considerable part of it consists of a natural flat basin or park completely rimmed with mountains. There is evidence that it was once a lake bed. Known as South Park, it is one of the largest areas of its kind in existence, having a length of 50 miles and a width of from 11 to 40 miles. It is highly productive of hay and, accordingly, has become a fine cattle-raising country. Many of its ranches cover several thousand acres each.

Placer or "gulch" mining was the *forte* of those early prospectors, and lode or "quartz" mining owed its start to a chance discovery. One of the most lucrative sources of placer gold was an area along a small stream about 1½ miles back from where it enters the South Platte at the Town of Alma. The first prospector in this section was Joseph Higginbottom, better known as Buckskin Joe. At one point the gravel proved unusually productive, and when bedrock was uncovered it was found to contain gold ore in place. Lode-mining claims were staked, and there followed a rush of such proportions that the townsite of Buckskin Joe was laid out and a post office established there. This was in 1861, and within a few months there were 1,000 inhabitants. In the same year Colorado Territory was formed, and this settlement

became the first county seat of Park County. The mine which caused its founding was named the Phillips, and it yielded about $300,000 in two years from ores which were treated first in arrastras and later in stamp mills. The easily worked oxidized deposits soon were exhausted, however, and the complex sulphides below them defied treatment. By 1863 Buckskin Joe was practically deserted and Fairplay had become the county seat. Today only a few rotted logs and piles of stones mark the positions of the once numerous cabins.

Although Buckskin Joe turned out to be more mercurial than Montgomery, Hamilton, Quartzville, Mosquito, and other mushroom camps that had one or more revivals before they eventually became ghosts, it did serve to create an interest in lode deposits which quickly led to important discoveries. Following these initial finds of gold ore, some unusually rich deposits of silver minerals were located, and for a number of years thereafter the region attracted chief attention as a silver producer. The discovery of silver was made in 1871 in the Moose Mine near the top of Mount Bross; and, although other notable mines were soon in operation, the Moose drew the most acclaim. It was directly owing to the opening of this property that the now defunct Town of Quartzville came into existence. The mine was situated at an elevation of 13,700 feet on the windswept north slope of the mountain. The absence of level ground and the scarcity of water precluded the establishment of a town there; and, as a result, the miners retreated to a more favorable location 2,000 feet lower to build their cabins. Thus was born Quartzville, which also became the home of men working in other nearby mines and of prospectors. It is recorded that, because of the stiff climb, the men employed in the Moose were unable, during bad weather, to reach the mine before 10 o'clock in the morning and were so tired from the trip that they were poor workers. Yet, despite these adverse conditions, the ore was so rich that the mine yielded handsome profits. From its discovery in 1871 until 1878, it produced $1,000,000. Before reduction plants were available near at hand, much of the ore was sent to Wales for treatment, being transported on burros to the bottom of the mountain, thence by ox team to Omaha, and from there by railroad to New York. Those shipments ranged in richness up to 1,000 ounces of silver to the ton.

Without lingering longer over the general history of the region, we may point out that its placer deposits have been washed and rewashed by white men and Chinese intermittently for more than 60 years both with and without mechanical devices, and that there is considerable current activity at various points. The gravels in the Hamilton-Tarryall and Fairplay areas are each credited with a production of well over $1,000,000. We may also observe that their records of lode mining parallel that of every western mining camp in that periods of activity and comparative idleness have followed one another in unbroken succession. Silver mining has been virtually nonexistant since demonetization of the metal in 1893, but gold mining has fared better. It is this latter industry that we will follow further here, with particular reference to London Mountain, which has been and remains the principal producing area.

London Mountain's contribution to the world's store of metal is estimated at varying figures up to $30,000,000, mostly in gold. Initial work was done there in 1875, and, during most of the intervening 59 years, one or more enterprises have been in progress. Unusually complex geological conditions have intensified the uncertainties that always accompany gold mining and, likewise, have added piquancy to the quest. The gamble there never has been a question of the existence or quantity of the ore. It occurs in veins so strong that there is no doubt about their being deep-rooted. However, by reason of seismic convulsions during past geologic eras, those veins have been torn apart at different points and their resulting sections so thoroughly juggled that this whole area of the earth's crust seems sometimes to be hopelessly jumbled. On various occasions operators have found a well-defined vein suddenly cut off by a blank wall and been obliged to go off into the country rock hunting for it. At times the search has failed, and what had been a profitable mining venture was all at once transformed into a sink for additional capital. In more than one case failure eventually to find the errant vein has forced a cessation of operations. Always, however, the knowledge that good ore was waiting there somewhere has proved an irresistible lure, and somebody else has come along to take up the search anew. Mistakes or errors in the judgment of predecessors have aided these newcomers by showing them, at least, in what direction not to go; and with this help the ore-bearing stringer has usually been relocated. Knowledge of hidden conditions has increased cumulatively as the probing continued, and examinations by mining engineers and geologists have likewise contributed from time to time to a better understanding of the subsurface puzzle.

Although London Mountain rises 13,161 feet, it is one of the minor elevations in the region where heights of 14,000 feet and more are common. It lies about six miles west of the Town of Alma near the head of Mosquito Creek whose two principal branches flow along its western and southern sides. It forms a part of the eastern slope of the Mosquito Range which runs north and south and divides the Arkansas and South Platte watersheds. Just across the crest of this range to the west is Leadville. It is only six miles away by an old stagecoach road across the pass which is now little better than a wide trail. The traveler by auto is obliged to drive a circuitous route that measures 66 miles—a fact that gives a better idea of the ruggedness of the area than could be conveyed by pages of description. North of London Mountain, only four miles across country but over the divide, is Climax, site of the world's foremost molybdenum mine. It is evident, then, that London Mountain is in a well-mineralized belt.

Without attempting a technical discussion of the geology of the area, perhaps we

LONDON MOUNTAIN AND NORTH LONDON MILL

The high mound at the left is London Mountain, viewed from the northeast. The North London mill is the building at the right. The mine is directly over the hill, the vertical scar above the mill marking the line of the aerial tramway that delivers crude ore to this plant. The connected workings of the North London and South London mines extend entirely through the upper part of London Mountain for a horizontal distance of 4,200 feet. The buildings shown are at an elevation of 11,300 feet above sea level.

SOLVING THE PROBLEM OF COOLING WATER

The structure at the left houses the compressors and a 50,000-gallon wood-stave tank for circulating cooling water. In summer the water supply is replenished as required by pumping from a nearby lake, but this body of water freezes solid in winter. However, Nature piles up snow as high as the building, and this is shoveled into the tank through the square door near the center of the picture. The air intake for the compressors is back of this door and to the left. Some of the workers at the North London Mine, where about 80 men are employed, are shown below. All are citizens of the United States.

can help towards a clearer understanding of the mining problems by explaining how the vein system became dismembered. The foundation rock consists of granites, gneisses, and schists of pre-Cambrian age. On top of these, and having a gentle dip or slope toward the east from the crest of Mosquito Range, is a series of sedimentary deposits. In order, from bottom to top, these are: a quartzite of Cambrian age, a white or gray limestone, and a parting quartzite which gets its name from the fact that it separates two limestone formations—a blue limestone, which is familiarly termed "Leadville" limestone because it is the ore-bearing horizon in that district, and the Weber grits. These sediments were laid down on the bed of an ocean that existed during the Paleozoic and early Mesozoic eras.

Towards the close of the Cretaceous period there began a mountain-making movement during which these strata were first gently folded and then crumpled and faulted, meanwhile being raised high above the level of the sea. During the earlier stages of folding there were numerous intrusions of igneous rocks. Two of these that particularly concern us here took the form of flows of porphyries that distributed themselves as sheets and followed along bedding planes in the white and blue limestone formations. The heat which they developed was a factor in the formation of the ore-bearing veins. Thus, both the intruded sheets and at least a major portion of the mineralized veins were present in the sedimentary rocks during the violent crustal movements and were, therefore, subjected to their rupturing influences. Chief among these movements was that which created the London fault.

To gain a mental picture of what happened, imagine a number of sheets of cardboard piled one on another and all resting flat upon a table. If we now exert great horizontal pressure upon the pile from two opposing sides, the cardboard will buckle and fold at some point, forming an elevation or ridge running roughly at right angles to the directions from which the pressure is brought to bear. If the horizontal thrust is continued, a point is reached where the cardboard is rent asunder along the line of weakness developed by the fold. When this happens, the sheets on one side of the break will be raised above those on the other side of the zone of shear.

The action that took place in the case of London Mountain was roughly analagous to that just described, and the result was a fracture or fault along which the strata moved. As reconstructed by geologists, "the movement that culminated in the fault first developed a great S-fold of anticlinal or slightly recumbent character, with the steep or overturned side of the fold facing west. That is, the fold caused the beds on the east to be elevated, or those on the west to be depressed. This movement finally resulted in rupturing the beds and developed into a great thrust-fault in which the eastern flank was shoved up above and somewhat over the western." The break came at the junction of the sedimentary rocks with the underlying igneous or Archean mass. The fault plane dips steeply to the east from 65° to 70°.

After the slip occurred, the strata that had comprised the overturned or western flank of the fold were left in contact with the Archean rocks, and their dip or angle of slope conformed to that of the fault plane. Since the rocks on the eastern side of the fault plane were elevated, they became more subject to erosion than the lower adjoining rocks on the west. As a result, the entire sedimentary series that originally capped the Archean base was subsequently worn away in this area. This produced the present condition in which the Archean rocks form the surface on the eastern side of the fault plane, with the steeply dipping sedimentary deposits abutting them on the west. While it is impossible accurately to measure the total displacement that accompanied this faulting movement, it has been determined that it approximated 2,900 feet. Investigating geologists have traced the fault for about fifteen miles, and in many localities it can be readily seen on the surface.

As is inevitably the case when movements of such magnitude take place, there were numerous accompanying effects. For one thing, there was considerable grinding, fracturing, and mashing of the rocks adjacent to the fault plane. Also, as is common, there was more than a simple faulting movement. Several hundred feet to the west of the main London fault and running generally parallel to it there occurred

another fault. This is termed the West London fault. During the movement of the block of rock between these two faults there were set up numerous strains which caused various cross faults. Some of these had steep dips while others were comparatively flat. One does not have to be a geologist to understand that all these jostlings of the earth's crust played havoc with the continuity of the ore-bearing veins that happened to traverse the section. The result was something like that which would be obtained if several slender sticks of wood were run through a batch of bread dough and the mass then kneaded with a few powerful strokes.

As already pointed out, this scrambled condition of the subsurface has brought despair to more than one mining man. Hunting the proverbial needle in a haystack has at times seemed an easy task compared with the problem of determining which way to look for a vein that suddenly disappeared against a wall disclosing not one but two or even three fault planes all running at different angles. The best-trained technical men have been stumped on occasions, and, as noted, wrong decisions have led to impoverishment and eventual withdrawal of more than one company because of expensive but unsuccessful explorations in search of the elusive ore.

Although this underground puzzle was bad enough to cope with, still further difficulties in the form of complex ores that were hard to treat have attended mining on London Mountain. The early operators worked in the oxidized zones where none of this trouble was encountered; but when the deeper-lying sulphide ores were penetrated by those that came later, they were found to be extremely obstinate. Thus, the matter of milling became an additional stumbling block in the path to success and proved the undoing of several operators who had succeeded in finding good ore.

Ore was first discovered at an outcrop high up on the north shoulder of the mountain, and the first entrance was made at that point. Rich ore was taken out of an opening which came to be known as the Bridal Chamber. Although operations are now being carried on at this high level at what is called the West London Mine, by far the greater proportion of the work of development has been done through two lower openings. The first of these was made on the north face of the mountain 230 feet below the discovery point and at an elevation of about 12,400 feet. From a site which was topographically favorable to the location of essential mine buildings, a crosscut tunnel, the Blanchard, was driven at an angle so as to cut the vein several hundred feet in from the portal. From this intersection a drift, called the Vienna Tunnel, was run southward on the same level through the ore-bearing zone. Another drift tunnel, 300 feet lower than the Blanchard, was later driven into the mountain from the south slope, cutting the ore about 1,000 feet in. Subsequently, the north and south openings were connected, thereby extending the workings through the upper portion of the mountain—a horizontal distance of 4,200 feet. There is also an intermediate drift, 60 feet below the Vienna, which is several hundred feet long.

For the most part, mining from both sides of the mountain was conducted until comparatively recently as one operation in what was known as the London Mine. During this period, all the ground above the Vienna Tunnel was stoped for a vertical distance of several hundred feet. In recent years the mining has consisted of several distinct operations. Thus, at present, the North London, West London, and South London mines are all active. In addition, the American is working a small section of ground through a shaft which enters the eastern slope of the mountain. Below the South London, in the valley formed by South Mosquito Creek, is the London Butte whose workings extend into Pennsylvania Mountain along the southward continuation of the same vein system.

Although all these undertakings are interesting enough to merit attention, space limitations prohibit such an extensive discussion, and we shall, accordingly, confine the remainder of this article to a brief account of current operations at the North London. This property is held under lease by the Fairplay Gold Mines, Inc., an organization which is headed by Benjamin Briscoe, former manufacturer of the Briscoe automobile, one of America's pioneer motor vehicles.

Following his withdrawal from the automotive field a number of years ago, Mr. Briscoe applied himself successfully to various business pursuits, among them the

MOVING IN A COMPRESSOR

The need for more air brought with it the problem of how to get a new compressor to the North London Mine in early spring, before the road was open. The dismantled machine was delivered to Alma by railroad and transported the remaining seven miles to the mill by trucks. A sled and 12-horse team were then called into play in negotiating the final 1,100-foot climb from that point. The picture above shows the outfit starting up the snow-covered mountain with the main frame of the compressor. At the right is a close view of the load.

WHEN WINTER COMES

Snowfall is heavy, and with no impeding trees the high winds form deep drifts. Each of the men in the picture above has one foot on top of a 20-foot telephone pole. On the opposite page is a view of the boarding house at the North London Mine. The chefs were obliged to dig a tunnel to get in and out of the kitchen door.

development of oil-refining processes in Canada. He foresaw at the beginning of the economic depression that one of the most secure and profitable businesses during the years to come would be gold mining. In association with his brother Frank, and others whom he interested, he therefore sought a promising location, and was led by investigations to choose the Alma district. The Briscoe family at that time purchased a 3,000-acre ranch in South Park, between Fairplay and Alma, and has since made it its home. The first mining venture of this group was at the old Champagne property at the head of North Mosquito Creek and a short distance north of London Mountain. When results failed to justify expectations, a consulting engineer of experience was called in for advice, and it was upon his recommendation that the lease on the North London was obtained.

The North London had been inactive for a considerable period, and from the time they took it over in the fall of 1932 until the following summer the new operators concentrated upon rehabilitating the structures and equipment both on the surface and underground. These preparations included placing in working order a concentration mill on North Mosquito Creek, 1,100 feet lower than the mine, and a 6,600-foot aerial tramway for transporting ore to it. The mill was pronounced ready for service in the spring of 1932, and was started on July 4. It was run until November of that year when it was closed down until May, 1933. Since then it has been operating continuously. As there has been insufficient time to prosecute mine development work to any great extent, and as the daily capacity of the mill about equals the maximum daily production of the mine, those in charge of mining have been confronted with the difficult task of finding and extracting ore at a sustained, rapid rate.

The principal veins are the London and the McDonald, of which the former is the larger and more persistent. Both are of the fissure type, the minerals having been deposited in fissures in the rock and, accordingly, have well-defined walls. These fissures are usually within the limits of the porphyry intrusions which, as explained, entered the limestones as flows and were subsequently uptilted steeply with them. The veins thus generally conform closely to the dip of the sedimentary series that incloses them. The association of the ores with the igneous intrusions is in distinct contrast to the conditions at Leadville, where, with the identical formations present, the circulating mineral-bearing solutions chose the softer limestones as locations for lodgment in preference to the porphyries. The Leadville deposits, however, represent replacements of portions of the limestones as distinguished from the filling of existing fissures.

We have just stated that the fissures usually are closely related to the porphyry intrusions. Until recently this was believed to be always the case. The discovery that there are exceptions to this rule accounts in large part for the success which is attending the efforts of Fairplay Gold Mines, Inc. During the many past years of mining on London Mountain there had grown up a theory that no ores were to be found in the blue limestone which lies between the easternmost porphyry and the fault plane. This was supported by the fact that an early crosscut driven through the limestone encountered no vein. Thereafter, this formation was assumed to be barren and, when the ore was periodically cut off by fault planes, the possibility of searching for its continuation in the limestone was never even considered. A few months ago, however, the present operators of the North London, after studying the existing conditions at one point in the mine, decided that the indications pointed towards displacement of the vein in the direction of the neglected formation. A crosscut was accordingly driven into the limestone, and tradition was upset. Stoping on the vein which was thus found has produced $100,000 in values so far, and there is reason to believe that at least that much more will be taken out. The ore body is 9 feet wide and has been opened up along a length of 150 feet. This deposit was developed through a winze sunk 150 feet below the level of the Vienna Tunnel. It is reported that operators on other portions of London Mountain have acted upon the revelation that ore does occur in the limestone and that they, too, have been successful in finding it there.

The ore from the London vein is a mixture of the sulphides of iron, lead, and zinc, with some copper. The gold and silver values are carried in these. No free gold can be discerned in the ore, although it collects at certain points in the mill. The silver content generally is no greater than the gold content, which ranges up to 5 ounces to the ton. At times the percentage of gold and silver drops off, and the ore becomes almost a pure sulphide of iron. This material is desired by the smelter for use as a flux in treating ores that are low in iron, and when it exceeds 30 per cent a reduction in charges is allowed. Accordingly, it is the practice in this mine to add sufficient iron sulphide to the richer ores to make sure that the concentrates from the mill will contain more than 30 per cent iron. No effort is made to segregate high-grade ore, and rich and lean materials are intermingled as they enter the mill circuit.

The rehabilitation program carried out prior to starting mining included the installation of modern and adequate equipment. Hauling is done with a Goodman storage-battery locomotive. An Ingersoll-Rand Type Ten 14&7½x12 belt-driven compressor which was on the property was used until a greater air supply was required, at which time an Ingersoll-Rand XRB unit of approximately 1,000-cfm. piston displacement was purchased. It is belt driven from a 150-hp. motor. Drilling in the mine is done with R-51 and N-38 stopers, N-75 drifters, and S-49 "Jackhamers." An L-29 "Pickhamer" also is used.

The tramway between the mine and the mill is a wood-tower structure which originally saw service in the San Juan mining district of Colorado. Buckets are rated at 780 pounds carrying capacity each, and a 24-hour supply of ore for the mill is transported by operating the cableway one 8-hour shift a day.

As previously stated, former operators experienced a great deal of difficulty in successfully concentrating the complex ore. Ample evidence of this is offered by the extent and varied character of the discarded equipment that surrounds the mill. It is estimated that fully $500,000 has been expended in this one small plant, each newcomer to the property having had his own ideas as to the best methods to install. Cyanidation was repeatedly tried, but was ineffective because of the copper content of the ore.

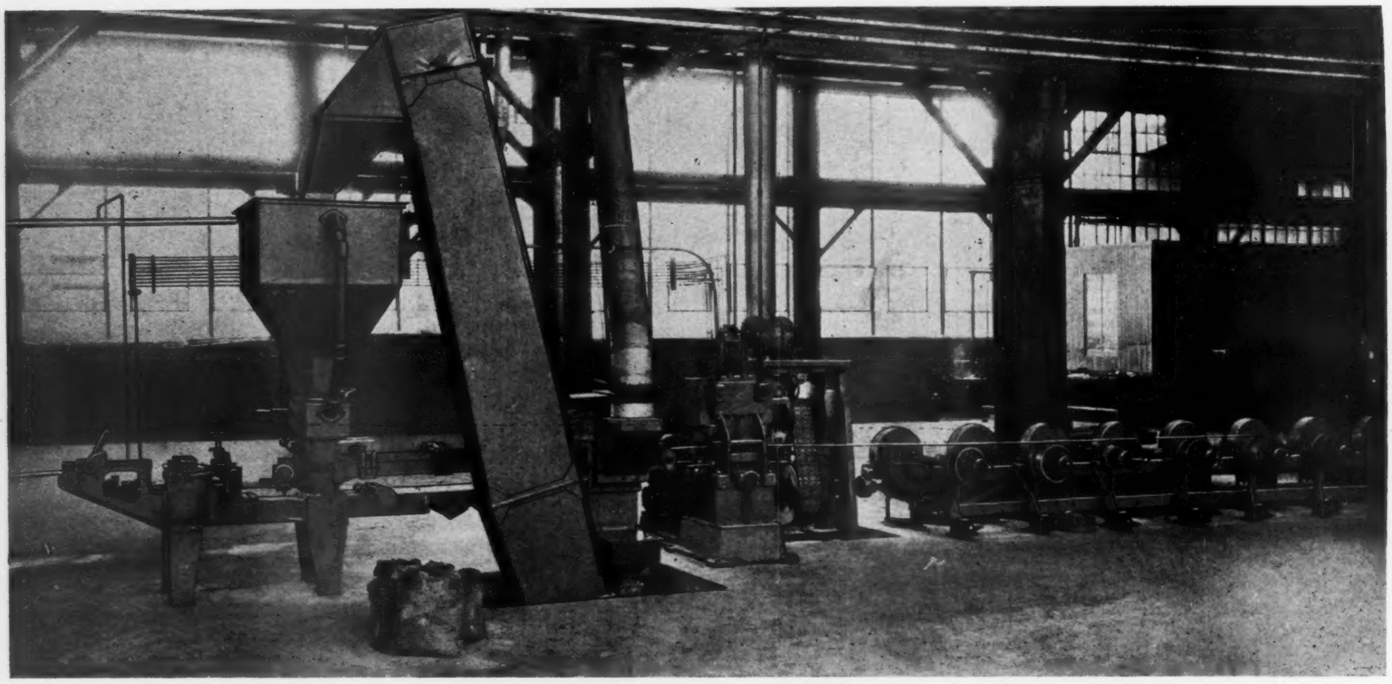
The present plant comprises a combination of conventional tables and flotation machines; and a recovery of from 93 to 95 per cent of the gold values is being made. Although the grinding capacity is only about 80 tons a day, the fact that a great deal of the ore comes from the mine in extremely finely divided form makes it possible to operate the mill on a 90- to 95-ton basis. Coarse ores go to a Universal crusher and the fines to a ball mill which is connected in closed circuit with three Wilfley tables. The overflow from the classifiers passes to six Denver Equipment Company flotation cells and then over two concentration tables. About two-thirds of the values are caught on the tables and one-third in the flotation cells. An average of four carloads of concentrates a week is shipped to the smelter at Leadville. These are trucked seven miles to Alma for loading. About 50 years ago a branch railroad was built from Alma to this mill site, but the rails were subsequently torn up during one of the periods when mining activities in the section fell off.

An unusual feature of the current operations on London Mountain is an agreement or treaty between the respective interests regarding their zones of activity. To obviate any conflict concerning transgressions on one another's ore bodies under the apex law, the West London, North London, and South London groups have arbitrarily divided the mountain into three horizontal sections running clear through the mountain and allocated them for working according to the levels at which the several mines are located. Thus, the West London, which is the highest of the three, has been awarded the upper portion, the North London the intermediate section, and the South London the lower ground.

Because of the high altitude, with its accompanying long winters of heavy snowfall, high winds, and low temperatures, the men at the mine are virtually marooned for months at a time, especially those that are not adept at traveling on snowshoes or skis. Within the mine, itself, the temperature remains practically uniform throughout the year, being only a few degrees above the freezing point, even in summer.

Price Briscoe is general manager of Fairplay Gold Mines, Inc.; O. G. Carstens is superintendent of the mine and mill; and Charles Fletcher is mine foreman. About 90 men are employed.

Dry-Cleaning Machine for Strip Steel



COMPRESSED AIR AND STEEL GRIT SCOUR WELL

Typical steel-mill installation of a Model B-7 DreiBrite automatic cleaning machine showing, from left to right: air-operated stock control, scourer with mixing and exhaust chambers, stock-pulling unit, and take-up reels. Each of the latter is operated independently so that a finished coil can be removed and a new one started without interfering with the movement of other strands. One or more strips up to 7 inches wide and .125 inch thick can be fed continuously at a speed ranging from 10 to 80 feet a minute. The machine has a maximum capacity of 2,500 pounds of steel an hour.

MANY months of industrial application have, apparently, proved the practicability of the DreiBrite process for removing scale and oxide from hot-rolled, annealed, or tempered steel sheets, bands, strips, bars, rods, tubes, and wire. As the name implies, it is a dry-cleaning process that is based on the principle of the sand blast but distinct from it in that the metal is subjected to a scouring and not to a blasting action, the medium employed being steel grit or shot carried in suspension in low-pressure air. It is now being used in place of acid-pickling, which is so destructive to material, plant, and equipment.

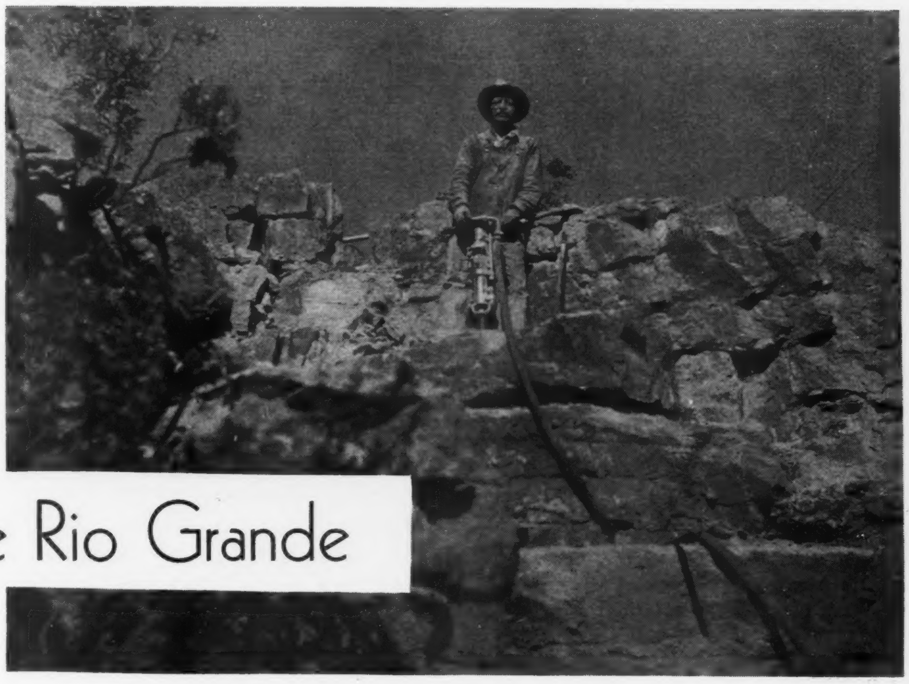
The machine built to do the work is available in several sizes, and consists of a scouring chamber, an air-and-grit mixing chamber, an exhaust chamber, and a grit hopper, in addition to a continuous conveyor, take-off and take-up reels, and an air-controlled stock-pulling unit. It is automatic in its operation, and can clean one or more strips, rods, etc., up to any reasonable width simultaneously. The strips, let us say, with their winding reels are successively pulled through scale-breaking rolls at the charging end of the machine bed, the mixing chamber, the scouring chamber, and the exhaust chamber at a rate varying from 20 to 150 feet per minute, depending upon their condition. All the while they are passing through the machine, the abrasive-laden compressed aid is blown from the mixing chamber into and through the scouring chamber at high velocity and in the same direction in which the strips are traveling.

The interior of the scouring chamber is constructed so as to give the air stream an undulating course, with the result that the stock is subjected to such a multiplicity of scouring actions throughout the entire length of the chamber that every part of it —edges, sides, upper and lower surfaces— is thoroughly cleaned in one pass through the machine. Upon emerging, it is free from pit marks, scale, and oxidation, and can be cold rolled or drawn to a bright, smooth finish also in one pass. A sample piece of 6-inch-wide, hot-rolled strip which was cleaned by this process and cold rolled without oiling has shown no signs of corrosion after a period of fifteen months in storage.

The stock-control levers and the air and the grit regulating valves are at one end of the scouring machine within easy reach of the operator. Compressed air at 20 pounds pressure is used. The abrasive can be supplied while the machine is in service and is returned to the hopper several times for re-use, or as long as it remains coarse. The fine material goes to the exhaust chamber and thence to a filter—making the entire system a dustless one. Parts that must of necessity be renewed frequently are made of rough castings to keep down replacement costs, and are accessible so that new ones can be substituted without disturbing the work in process of cleaning.

INSTRUCTIONS FOR SOLDERING ALUMINUM

TIN or other solder may be used successfully in connection with aluminum provided the following procedure, which is attributed to the Technologic Institute of Stockholm, Sweden, is adhered to. The difficulty is to obtain surfaces that are free from oxides. As commercial aluminum and most of its alloys contain more or less silicon, this can be done by cleaning them with hydrofluoric acid or with solutions developing that acid; by carefully removing all traces of the acid with water; and then by dipping the metal in alcohol, preferably methanol, to get rid of the water. Any solder will serve the purpose; but the kind utilized depends upon whether or not resistance to corrosion enters into account. If it does not, then an alloy of 85 per cent tin and 15 per cent aluminum is satisfactory; but in cases where it does, it is necessary to employ a solder with a higher melting point, one, for example, composed of 90 per cent aluminum, 9 per cent copper, and 1 per cent silver.



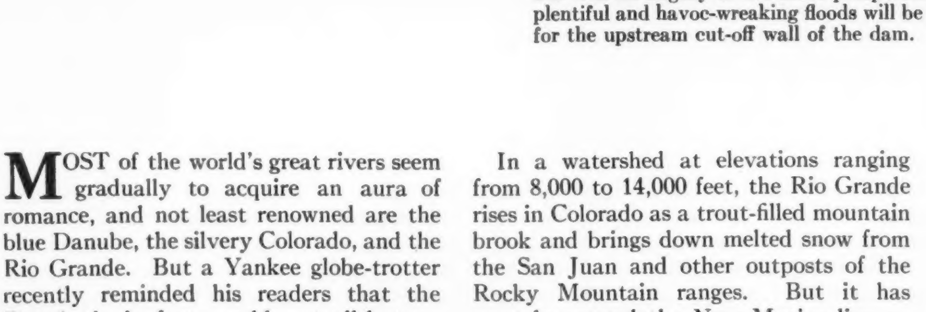
Taming the Rio Grande

R. F. CRAWFORD

DRILLING PASTORAL

El Vado Dam is rising in a semiarid land of sunshine which has been peopled for countless generations by agrarian Indians. The sound of air drills has seldom been heard there, but it is an augury of the more prosperous times to come when irrigating water will be plentiful and havoc-wreaking floods will be curbed. The driller shown here is excavating for the upstream cut-off wall of the dam.

MOST of the world's great rivers seem gradually to acquire an aura of romance, and not least renowned are the blue Danube, the silvery Colorado, and the Rio Grande. But a Yankee globe-trotter recently reminded his readers that the Danube is, in fact, not blue at all but exceedingly brown, and the same must be said of the other streams mentioned, for they are all inveterate silt carriers. The Rio Grande is, indeed, a grand and turbulent river during flood periods; and the Spanish conquistadores who named it perhaps first saw it at flood stage. From the days of the Alamo and the struggle of the Lone Star State to achieve independence, throughout our period of colonization and development in the Southwest, the stream has never ceased to play a dramatic frontier *rôle* and to be at once a source of life and wealth and an incorrigible and destructive monster.



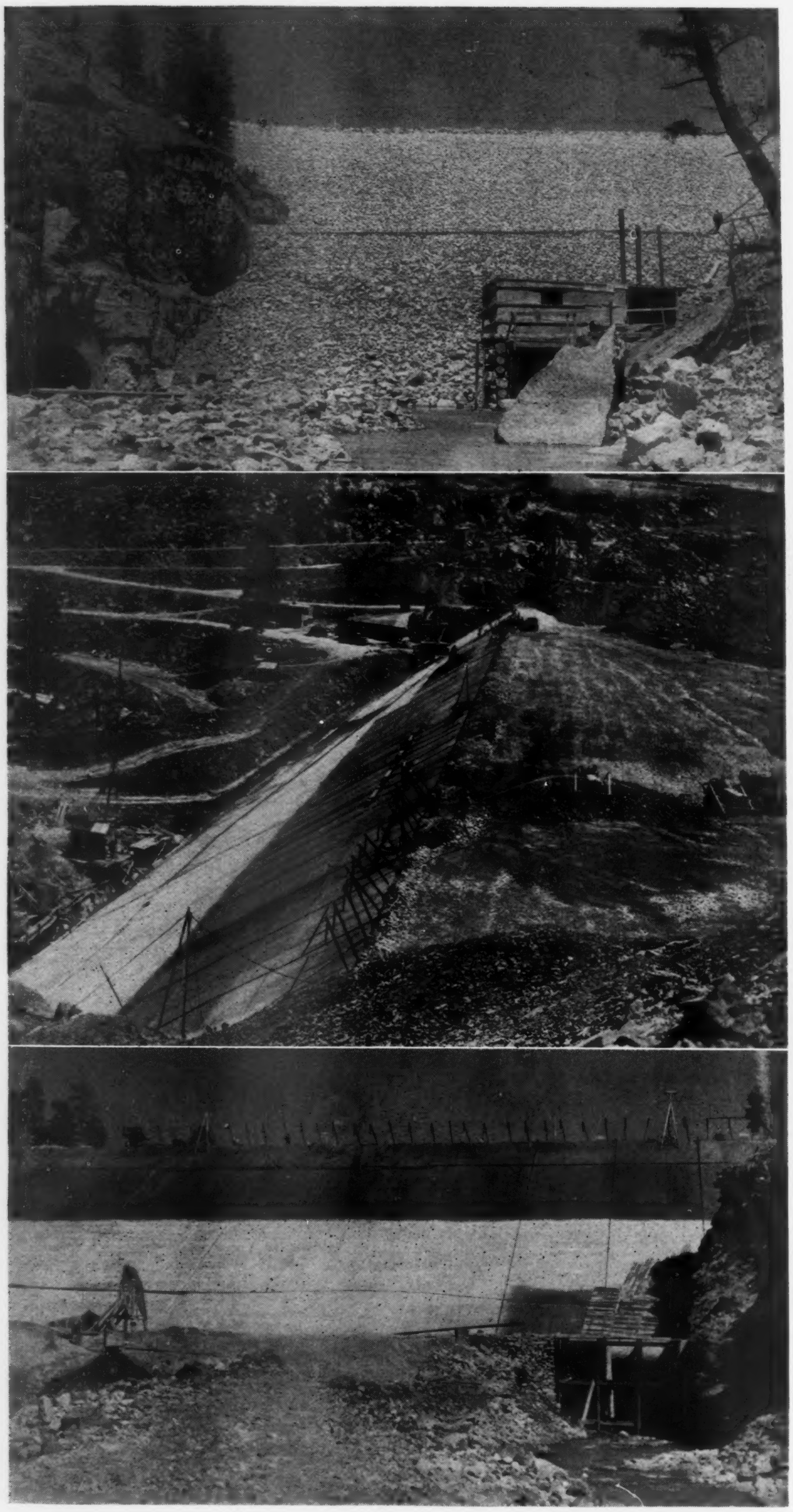
MAXIMUM SECTION THROUGH DAM

In a watershed at elevations ranging from 8,000 to 14,000 feet, the Rio Grande rises in Colorado as a trout-filled mountain brook and brings down melted snow from the San Juan and other outposts of the Rocky Mountain ranges. But it has scarcely crossed the New Mexico line on its 1,500-mile march to the Gulf before it begins a task of moving veritable mountains of eroded material seaward. Passengers on the *Chief* and other trains of the popular Santa Fe see Albuquerque as a picturesque but thoroughly modern city of some 30,000 people; and they find it a little incredible that old residents can recall a period in which the Rio Grande flowed directly across the present townsite. Until recently the methods used to control the course of the river and to utilize it for irrigation were scarcely more scientific or better coördinated than those that were employed in the years gone by native Indians and Spanish peons.

There is every reason to believe that Indians were using effective irrigation systems in cultivating the rich alluvium of this fertile valley during the Crusades, possibly before the beginning of the Christian era, for nearly all the present villages are situated close to the river, or one of its tributaries, and have irrigation systems similar to those adjacent to older, deserted pueblos.

Silt is deposited throughout long stretches of the valley at an almost spectacular rate, and for centuries past it has been the habit of the stream gradually to build up its bed to a level higher than the valley floor until it actually runs in a broad groove on a ridge of silt. The higher this ridge becomes before a flood carries the river over low banks to inundate the entire valley, the more portentous its threat to ranches and human habitations. The stream bed at San Marcial, just above Elephant Butte Reservoir, is some 15 feet higher than it was in 1880; and at this point, in the fall of 1929, the Rio Grande gave a spectacular demonstration of the havoc it can work when excess rainfall brings it to flood stage. A railway bridge and considerable trackage were destroyed, and the railway-terminal town of San Marcial has since been virtually abandoned.

When depositions of silt elevate the river to a level higher than that of the valley floor, widespread areas of the best



THE DAM FROM THREE POINTS OF VIEW

Occupying a site in a narrow canyon of the Chama River in New Mexico, the El Vado Dam will contain 600,000 cubic yards of compacted gravel. Its downstream face (top picture) is being paved with rubble, while its upstream face (bottom picture) is being sheathed with steel plates. The center view, taken from one of the abutments, shows the steelwork being carried upward as the fill progresses.

agricultural lands are impaired by oversaturation and made alkaline through seepage, while a large percentage of the stream flow is wasted as the result of evaporation. It is estimated that most staple crops require a depth of 4 feet of unsaturated soil above the watertable for maximum production, and that this desired condition obtains throughout only about 30 per cent of the 123,000 acres of the central valley. Any comprehensive program of river control must, therefore, include extensive drainage systems, as well as flood control, irrigation, and desilting structures.

Formulation of an adequate program of this sort has been complicated by the extent of the area involved and by the difficulty of financing a project which is principally to benefit some 55,000 of the agrarian population of a sparsely settled state. Much of the best valley land has been allocated to individual Indians, or as communal ranches to pueblos, and these areas cannot be assessed. Precipitation throughout the watershed is seasonal and highly erratic, the mean monthly flow of the river ranging from 42,000 acre-feet for January to 400,000 acre-feet for March; and prevailing soil conditions and lack of vegetation make for rapid run-off and abnormally rapid erosion.

Much data covering run-off, stream flow, and origin and deposition of silt has been compiled during the past 40 years by the U. S. Bureau of Reclamation and by state and local agencies; but no organization competent to deal with the problems was formed prior to the creation, in 1923, of the Middle Rio Grande Conservancy District. This comprises virtually all the irrigable sections of the Rio Grande Valley in New Mexico lying aboveElephant Butte Reservoir, and such other areas as may be required for the construction of conduits or dams in the river or in tributary streams. Administration of the district is vested in five directors and in a board of commissioners appointed jointly by judges of the two judicial districts lying within its boundaries.

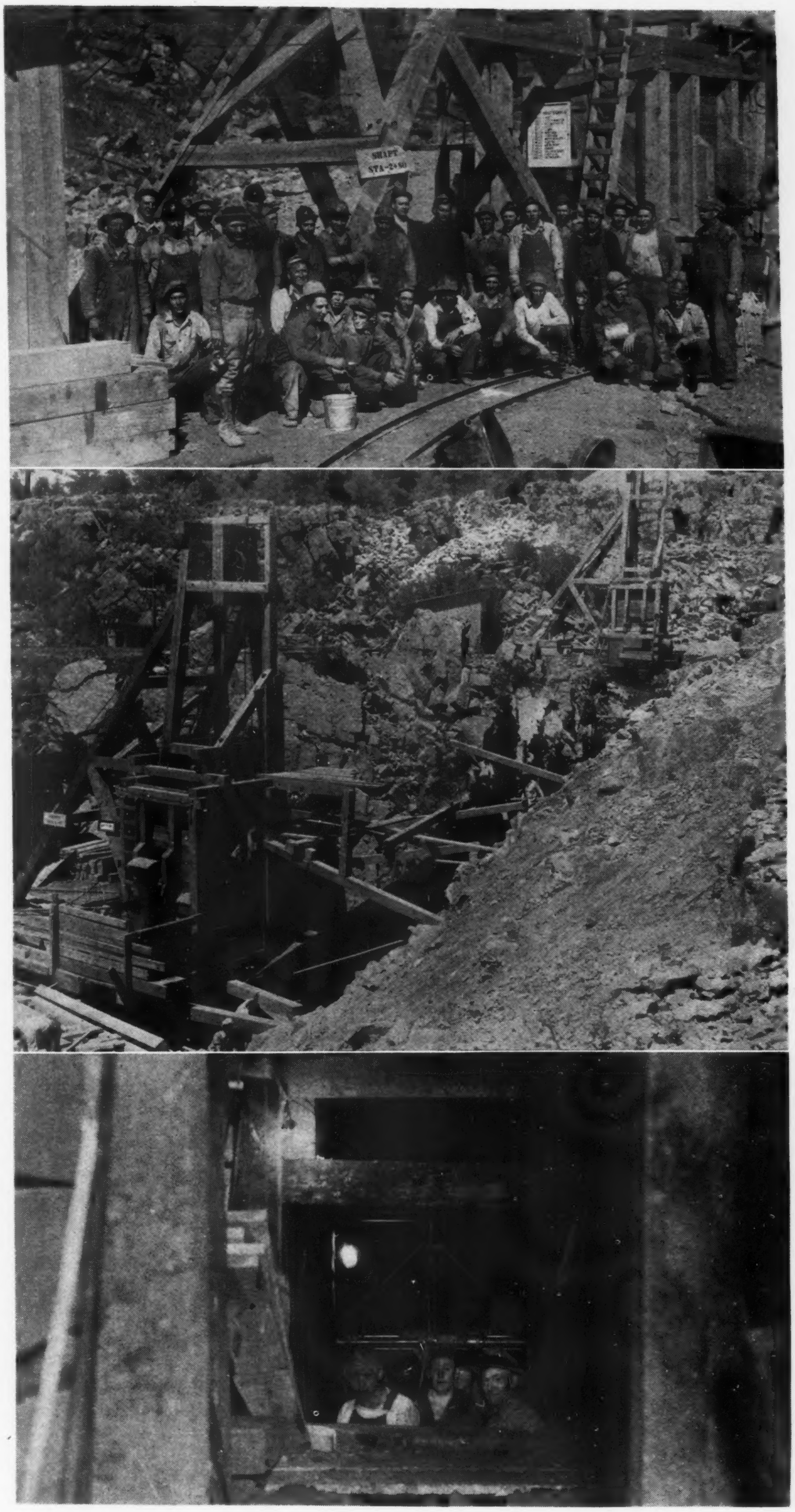
An engineering force was engaged in 1926, and reconnaissance and field and laboratory studies have since been carried on covering every phase of the problems involved, some of this work being done in collaboration with the Bureau of Reclamation. In the neighborhood of 23,600 parcels of property have been appraised and assessed, and surveys made of 11,300 holdings, their unmapped and indefinite boundaries being the result of land transactions made in the course of some ten generations subsequent to the original Spanish grants. Plans have been prepared and work is now in hand on a complete system of drains, diversion dams, and irrigation canals and laterals which are to supplant all the systems now in use there—these outmoded works representing the more or less haphazard evolution of

ancient systems. It is estimated that 286,000 acre-feet of water will be recovered annually through effective drainage. An arrangement of levees and permeable jetties has been chosen as the most effective means, within the funds available, of confining and deepening the main channel. Levees have been designed to protect against a maximum flow of 50,000 second-feet. Channel dredging and flood-detention reservoirs were also studied as possible methods of flood control, but were not considered economically feasible at this time.

In 1927, in behalf of the Indian lands involved, Congress appropriated $50,000 to cover costs of preliminary surveys and plans, and in 1928 added $1,593,311 for the construction of reclamation and flood-control works. The completed program, as now outlined, is estimated to cost something in excess of $11,000,000; and enabling legislation enacted by the New Mexico State Legislature in 1927 authorized the sale of district bonds which are a lien on all property excepting Indian lands. Current issues to the amount of $5,784,000 have been purchased by the Federal Reconstruction Finance Corporation.

The first structure to be built for the dual purpose of irrigation and flood control is the El Vado Dam located on the Rio Chama some 75 miles above its confluence with the Rio Grande and about 175 miles north of Albuquerque. The Rio Grande is dry for an average of 39 days each year between Albuquerque and the Elephant Butte Reservoir, and the dam is designed primarily to store flood waters for release during the dry season—increasing utilization of water for irrigation in Colorado recently having accentuated the need for storage facilities of this type. The 650-square-mile drainage area of the Rio Chama above the dam site offers the most prolific source of water in New Mexico, the average annual run-off of 310,000 acre-feet being derived partly from rains and partly from melting snows. Nine separate designs have been made covering a dam on the chosen site—a narrow canyon having walls of sandstone and shale. The fractured condition of the sandstone in the east abutment dictated selection of a gravel-fill structure having unique provisions for a cut-off below the foundations and an upstream facing of welded steel plate.

The dam is to be 1,200 feet long at the crest, is to rise 175 feet above the stream bed, and will contain 600,000 cubic yards of gravel fill with an upstream slope of $1\frac{1}{2}$ to 1 and a downstream slope of 2 to 1. The maximum thickness between the upstream and downstream toes of the footings will be 620 feet. A loose-rock fill 40 feet deep is being placed along the downstream toe. Something more than 80 per cent of the total gravel and rock yardage is now in position. A 20-foot roadway will be constructed on the crest of the dam, and a specially contoured, convex steel and reinforced-concrete parapet is to rise 4 feet



WHERE DAM BUILDERS BECOME MINERS

To make certain that the 36-inch concrete cut-off wall connecting with the steel facing is moored in solid material, vertical shafts are being sunk to depths as great as 136 feet and exploratory drifts run from their bottoms. The top picture shows a shaft crew and the bottom one a skip at a crosscut level. The headframes of two of the shafts in the east abutment are pictured in the center.

EXCAVATING IN SPILLWAY

A spillway, 1,000 feet long, will extend through the west abutment. The picture at the right shows trenches being dug in the bottom of this channel preparatory to concreting it. A driller at work on the spillway floor with a "Jackhamer" is shown above.

above the crest to protect it against wave action. This miniature sea wall will be provided with a concrete base and represent an upward extension of the metal facing.

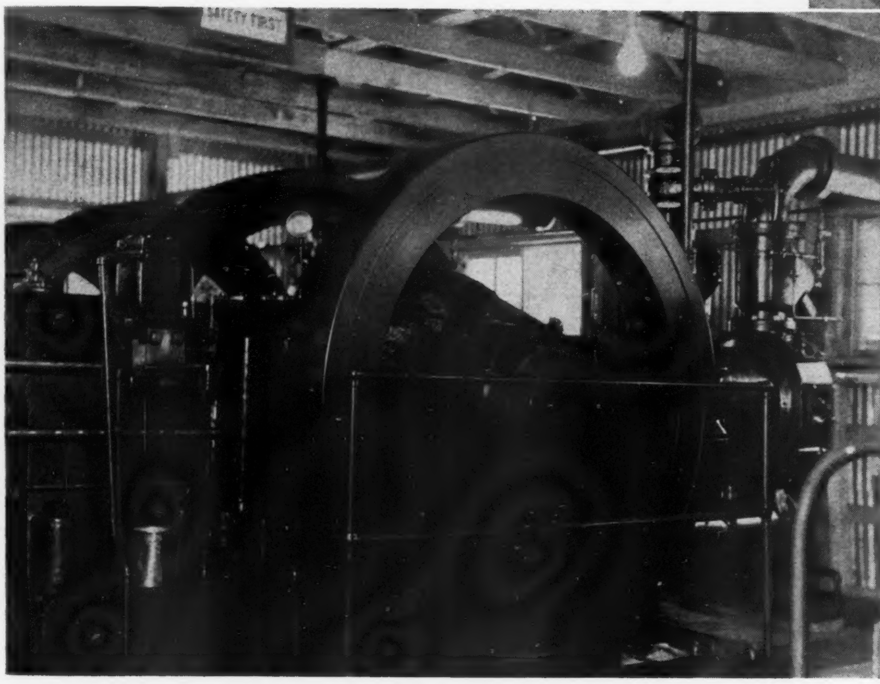
Preliminary work included the building or improvement of some sixteen miles of mountain road between the Town of Tierra Amarilla and the dam site, as well as the erection of a suitable camp for use during the construction period. Besides a commissary, a kitchen, and a mess hall capable of accommodating 150 to 200 men on each of the three shifts worked, the camp comprises six frame and ten frame-and-tent dormitories; a sheet-metal structure housing a machine shop, compressor room, and drill-steel shop; a woodworking shop; an office building; a clubhouse; and a stone cottage occupied by the construction superintendent.

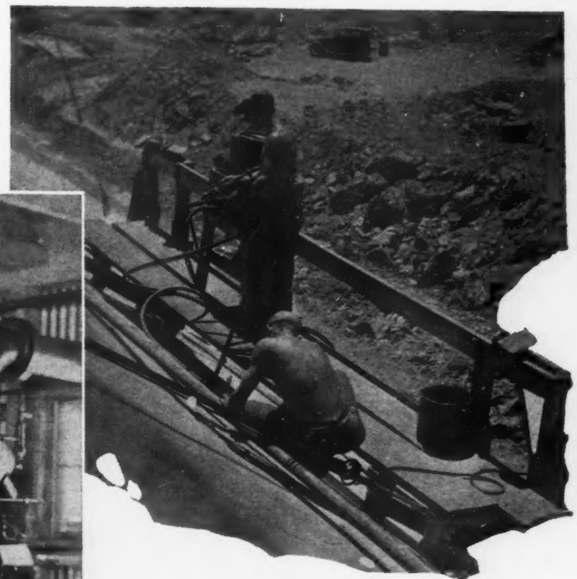
The stream was diverted temporarily by an earth-and-rock-fill cofferdam through two 5-foot corrugated steel pipes while a 12-foot horseshoe-section diversion tunnel was being driven 666 feet through the west abutment. This tunnel is on a tangent except for a 30-degree angle 100 feet from the river outlet. It was advanced by the bench-and-heading method with S-49 "Jackhamers" and bar-mounted N-75 drifters, air being supplied by two POC-2 oil-engine-driven compressors having a combined displacement of 1,200 cfm. Alternating beds of sandstone and shale were encountered, with many small lenses of shale interspersed in the sandstone. The nature and angular dip of the formations resulted in a heavy overbreak and exposed surfaces of shale that slaked rapidly under contact with air. Therefore, a conventional concrete lining would, it was estimated, have required an excess of 30 per cent of concrete. As an alternative, 16x36-inch corrugated liner plates of 11-gauge steel and having 2-inch flanges were erected to form a horseshoe section 12 feet 3 inches in diameter, the plates being supported by keyways and dowels in the invert. The invert was made by filling in screened gravel to within 9 inches of grade and by pouring and screeding the 9-inch concrete lining upon this base. Plates, each 16 inches wide, were erected in pairs, and spaces between walls and plates were filled by hand with quarried rock and gunited to a depth of 8 to 12 inches, the plates being held in position by jacks. Wire mesh was secured to the inside of the plates, and two N-1 cement guns were employed in placing the 3-inch layer of concrete.

A monolithic concrete gate structure gives access to the upper portal, and a 34-foot section of adjacent tunnel was grouted through holes in the liner plates. A trash rack will be installed, and stored water will be released through this tunnel by a 78-inch-diameter butterfly valve provided with a 36-inch access manway. The tunnel conduit will consist of a 78-inch steel penstock which will branch and discharge through two 54-inch needle valves located at the downstream end. Tunnel driving and lining were done by force account under supervision of the district officials.

The 82,000 cubic yards of excavation for the operating spillway through the cliff forming the west abutment has been largely completed. This spillway is to be 1,000 feet long, with a base width varying from 32 feet at the intake end to 12 feet at the outlet and with a 100-foot drop in elevation between the intake and the discharge. Spillway sides will have a slope of $\frac{1}{4}$ to 1. All their service areas are to be faced with steel plate—the remainder being surfaced with reinforced concrete by the gunite method. The 36x23-foot radial gate which will regulate the flow in this spillway is thought to be the world's largest. Contract for the spillway excavation was awarded to Shufflebarger Transfer & Storage Company, Albuquerque. Spoils were wasted into the canyon below the dam. Final dressing and lining operations are being handled by the district under force account.

Gravel for the dam is being excavated from selected beds located approximately one mile from the site. An area about 35 feet wide was stripped of from 7 to 13 feet of silt overburden with a Bucyrus-Erie 50-B crawler-mounted, diesel-driven dragline with a 60-foot boom and a $1\frac{1}{2}$-cubic-yard bucket. The 9-to 13-foot stratum of gravel thus exposed is loaded into 3-yard Indiana dump trucks by a 50-B $1\frac{1}{2}$-cubic-yard shovel, the dragline progressively





SOURCES OF AIR AND ONE OF ITS USES

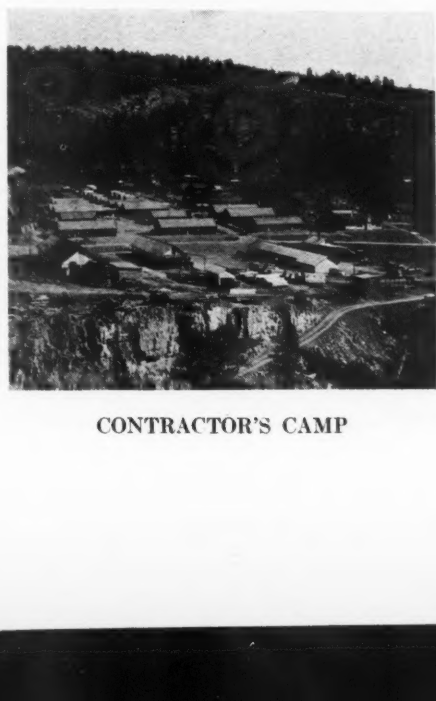
These two oil-engine-driven compressors (left), having a combined piston displacement of 600 cfm., are supplying compressed air for drilling and for various other purposes. Spray painting of the steel facing on the upstream slope is pictured above.

throwing stripped material into adjacent trenches from which gravel has been removed. Two 35 Caterpillar tractors equipped with bulldozers spread the gravel in 8-inch layers as it is dumped on the dam. It is then wet down by two hose lines and compacted by a 10-ton roller drawn by a tractor. A No. 33 pneumatic backfill tamper is employed in tamping fill against the upstream steel plate. Coarse rock for use in paving the downstream face is obtained from dumped material and loaded by hand into small trucks. Hauling from the gravel pit to the dam is being done by Springer Transfer Company, of Albuquerque, which is employing about 60 men on three shifts.

For the upstream facing, ¼-inch-thick steel plate is being applied, as filling progresses, in 296x98¾-inch sections with V-type expansion joints on 25-foot centers. Plates are assembled in position with bolts, and all seams are welded electrically—beveled edges being provided to facilitate welding. Some 60,000 linear feet of weld will be required in constructing this face.

Engineers for the district propose to carry a reinforced-concrete cut-off wall, 36 inches thick, not less than 5 feet into solid rock or other impervious formation at all extremities of the steel facing and to drill 40-foot holes on 5-foot centers for grouting under 100 pounds pressure before the wall is poured. S-49 "Jackhamers" are being used in excavating rock and N-75 drifters for grout-hole work. Drill steel is reconditioned by a No. 34 sharpener and a No. 6F oil furnace, while shanks are dressed with a No. 4K grinder. Two Star well drills are employed in exploratory work, and careful analyses also are made of formations penetrated by the drifters.

It has been impossible to determine precisely from original exploratory data the nature of the materials underlying the cut-off, and the engineering staff has deemed it essential to sink four shafts, 4½x8 feet inside timbering, to depths ranging from 100 to 136 feet. A total of six shafts may be needed to permit thorough exploration of these footings. The shafts are provided with 30-foot headframes and are served by Sampson hoists and 20-cubic-foot auto-dump skips. As the shafts penetrate satisfactory strata, 3x6-foot timbered tunnels are driven to points of intersection, a careful analysis being made of the formations traversed. Concreting is carried on from the bottom upward, and CAW31 stopers are employed in excavating for successive lifts. Cameron No. 7 sinker pumps and No. 25 sump pumps have served in dewatering shafts and tunnels. Special steelwork is embedded in the top of the cut-off wall to engage the plate on the upstream face and to provide an expansion joint.



CONTRACTOR'S CAMP

Aggregates are produced by a Cedar Rapids crusher and screening plant, gravel being stored in a stock pile for a 2-month period to remove moisture and to facilitate screening. Water for washing is supplied by a pumping unit integral with the plant, which is capable of processing about 20 cubic yards an hour.

With water standing at elevation 6,902, or 160 feet above the stream-bed level at the dam, there will be formed a lake about six miles long and having a surface area of 3,500 acres. The reservoir storage capacity of 198,000 acre-feet will be equal to more than half the mean annual run-off of the stream at this point. Although there will be a considerable fluctuation in level, this lake should add something to the appeal of this popular resort region.

C. H. Howell is chief engineer of the Middle Rio Grande Conservancy District; H. V. R. Thorne is construction superintendent on El Vado Dam; and Chas. P. Seger is resident engineer.

AN ERA OF HIGHWAYS

THIS is truly an age of roadbuilding. From every corner of the world comes news of the carrying out of vigorous programs of highway improvement. Although there is a great divergence of opinion among the leading nations on most matters, all of them are apparently agreed that good roads are essential to internal development. The necessity of putting men to work is, of course, a strong urge for road work at this time, but it is by no means the only impelling motive behind the movement.

Caesar recognized the vital function of roads in military tactics, and left a network of heavy-duty highways wherever he and his legions passed. These were engineered strictly from the viewpoint of martial utility. In order that the troops that traveled them might be safeguarded from surprise attacks, they kept to the open, high country as much as possible. With the passing of the Roman Empire, roads fell into disuse. There was no place for them under the feudal system. Thus, although Caesar built some 25,000 miles of highways in France, none, practically speaking, was available at the time of the Crusades, when trails were constructed along which the travelers to the Holy Land might march. The feudal lords and the communal governments along the way were quick to sense the opportunity to exact payment for passage through their properties, and tolls were generally imposed.

The first real stimulus to roadbuilding in Europe came in the middle of the sixteenth Century, when wheeled vehicles were brought into general use. At first such equipment was employed only in the cities, and it was fully 50 years before improvements in design permitted them to travel the rural roads. Even so, every overland journey was a perilous one. It is written that in 1681 King Louis XIV had to make five overnight stops in journeying from Chalons to Paris, a distance of 95 miles. Bridges were virtually nonexistant, and coach passengers counted themselves fortunate if they escaped with frequent duckings.

France saw her roads ruined many times by invaders and revolutionists, but she found cause during the World War to give thanks that she had always put them in good order. When Verdun was cut off from railroad communication, 190,000 soldiers and 22,500 tons of munitions were moved 40 miles from Bar-le-Duc over the Voie Sacree in just two weeks. Without a serviceable highway, the defense of this stronghold would have crumpled.

It is perhaps because of the freshness of this incident in her memory that France is taking a leading part in building roads today. Naturally, also, she has an eye out for tourist dollars, particularly since Americans prefer to do their sight-seeing from automobiles. In any event, France now ranks first among the nations in point of ratio of highways to area, and is second only to the United States in total mileage. Figures recently published in *Foreign Trade*, the organ of the United States Chamber of Commerce in France, show that for each square mile of land France has 3.12 miles of roads. Great Britain is second with 1.56, after which come the United States with 1.01, Germany with .73, and Italy with .42. With 3,018,750 miles of highways, the United States stands first in total mileage by a large margin, as France, of vastly smaller size, has 407,500. Next in order are Great Britain, 178,750; Germany, 150,000; Australia, 103,125; New Zealand, 65,000; and Italy, 43,750.

OUR COVER PICTURE

THIS underground view is unusual for the clarity with which it shows a massive vein of quartz. It was made in one of the properties of Bralorne Mines Limited in the Bridge River mining district of British Columbia. The drill is an R-51 "Stopehamer." The photograph was taken by Leonard Frank.

JOHANNESBURG TO CELEBRATE

IF ANY city in the world can be said to be built upon gold, it is Johannesburg. But for the finding of yellow metal in its underlying reefs, there probably would be no city there now. Just as the Witwatersrand is the most lucrative source of gold in the world today, so is Johannesburg the most famous and most populous mining city. It is one mineral-producing center that has far outstripped the appellation of camp, although its commerce still consists chiefly of ministering to the wants of the mines and their workers.

Prosperous even before the price of gold rose, Johannesburg is now positively opulent. By way of celebrating its good fortune, it is already making plans to observe its jubilee in 1936, and it is announced that a British Empire Exhibition will be one of the *fête's* important features.

The city took its name from Johannes Rissik, surveyor-general of the Transvaal, under whose direction it was laid out in 1886. The town grew rapidly, but by 1890 the surface ores had become exhausted, and that year was one of great depression. With the equipping of the mines for deep work there was a quick revival, and by 1895 the vast worth of the properties had been demonstrated so conclusively that the prices of their shares increased precipitately.

The outbreak of the Boer War led to a virtual abandonment of the city, and when mining was resumed there was such a shortage of labor that 50,000 Chinese coolies were imported. When native labor again became plentiful, those Celestials were returned to their own country.

With a population of 260,000, nearly 150,000 of whom are whites, Johannesburg today covers 82 square miles, is modern in every respect, and seems destined to continue in healthy growth for many years to come. By way of perpetuating its position, it turns out, at the South African School of Mines and Technology, competent technicians for its principal industry.

Industrial Notes

Stonhard Stonetite is the name of a new transparent liquid waterproofing for structural walls that is said to seal the pores effectually against the penetration of moisture without discoloring the surfaces. It can be applied by brush or by air spray.

What is claimed to be a new process of manufacturing aluminum has been developed after five years of experimenting by the Bohn Aluminum & Brass Corporation, Detroit, Mich. The interesting feature of it is that alunite, which is found in the United States, is used instead of an imported mineral.

Canada is now said to be the world's largest producer of palladium. Discovered and named by Wollaston in 1804, this member of the platinum group has, until recently, been little known outside of the electrical and dental fields. Today, however, thanks to industrial research, the metal is finding new applications in the making of jewelry and in the decorative arts.

Employing the same principles of heat resistance that have been so effective in the manufacture of its Golden Ply Tires, The B. F. Goodrich Company, Akron, Ohio, has developed a new conveyor belt for hot materials. It is claimed for the Golden Ply Hot Material Belt, as it is called, that it is highly resistant to abrasion even after long exposure to heat and that its flexing life, in its original state, is 85 per cent greater than that of the common run of belts of this kind.

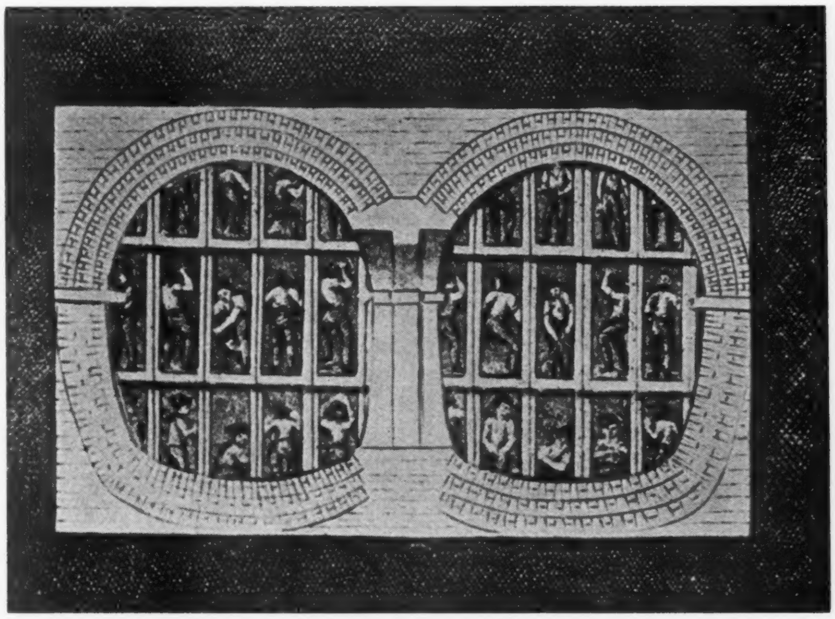
A new air separator for extracting oil and water from compressed-air lines has been announced by Sprayco, Inc., Somerville, Mass. It consists primarily of a cooling coil and a series of baffles. A small volume of water circulating in the coils lowers the temperature of the air and this, together with the reduction in the velocity and the change in the direction of the air flow, causes the moisture and oil vapor to condense on the baffles. The condensate collects in a reservoir in the lower part of the separator, which is available in two sizes—one with a capacity of 40 and the other of 100 cfm. at pressures up to 100 pounds.

A neat little tool for the electrician is being offered for sale by the Star Fuse Manufacturing Company. It is in the form of a pair of pliers that he can use also for test purposes. It is made of a bakelite and fiber compound, and carries a carbon lamp in series with a 1,600-ohm resistance. This lamp glows red when current is on the line but gives no warning signal in the case of a high-resistance leak or when moisture is present. For testing base plugs or lamp sockets the pliers are provided with a pair of prongs. These are at the forward end of the tool and are hinged so that they can be folded back when testing cut-outs and switches.

Beryllium copper, a new Anaconda alloy, is being made into so-called safety tools for use in and about places where inflammable and explosive materials are manufactured or handled and where the setting up of sparks may have serious consequences. The alloy is more than 97 per cent pure copper. It is guaranteed not to give off sparks even when struck against other metals or materials, is rustproof and resistant to a wide variety of acids, and is said to be exceptionally strong and durable. Beryllium-copper tools, including hammers, chisels, scrapers, sledges, pinch bars, screw drivers, picks, wedges, etc., are being put on the market by Stanley Tools, New Britain, Conn.

Changing the course of a river, building a bridge on dry land, and then permitting the stream to flow under that bridge in its accustomed channel are phases of an engineering project that is now underway at Omaha, Neb. To the layman it may sound highly spectacular; but to those on the job it is just another contract to be fulfilled in the most practicable and economical way. The river is the Missouri which, at the point in question, is now being diverted by a series of revetments so that the bridge piers can be sunk in and erected on the exposed river bottom, thus greatly facilitating the work. The cost of the undertaking is estimated at $1,600,000, and is said to be far below what it would be if it were carried out in the usual way.

The Electric Hose & Rubber Company, Wilmington, Del., has lately put on the market two new types of air hose designated, respectively, Electric Portable Compressor Hose and Electric Rock Drill Hose. The first is designed primarily for portable-compressor use and for other services in which oil may be blown into the air line. This hose is lined with a compound that is said to be resistant to heat and not to disintegrate or peel off even when in continual contact with oil. Rubber is thus prevented from passing through the line with the air and from clogging tools and machinery. The rock-drill hose has been developed for use in mines and quarries, on construction jobs, etc., where operations are of such a nature that the flexible air lines must be dragged about as the work progresses. This hose is covered with an extra-heavy layer of rubber compounded and cured to withstand the abrasive and cutting action to which it is exposed at all times. Its tube is of a special composition that is highly resistant to heat and oil. Both kinds of hose are reinforced with strong, tightly twisted cords spirally braided around the tube and completely surrounded by rubber.



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By means of this shield, invented by Sir Marc Isambard Brunel, workmen were enabled more than a century ago to excavate the twin Thames Tunnel which was begun in 1825 and completed in 1843. It was first used by pedestrians, and more than 25 years later, after its purchase by the East London Railway, formed a connecting rail link between Wapping and Rotherhithe. This interesting picture, showing the men at work behind the shield, is reproduced by courtesy of *The Railway Gazette* and originally appeared in a pamphlet published in 1838 by the Thames Tunnel Company.

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